THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 57 JUNE, 1935 No. 2

A GENETIC STUDY OF CERTAIN CHARACTERS IN VARIETAL HYBRIDS OF COWPEA[1]

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ONE PLATE

INTRODUCTION

There are two local types of *Vigna sinensis* Endl. in Luzon; these are known as "sitao" and "paayap." Sitao (sometimes called *V. sesquipedalis* Fruw.) is the long-podded pole-bean type. Paayap is the bushy type with an erect vine. The cowpea varieties of the latter type are discussed in this paper. The cowpea plant is considered valuable as a soil renovator, as a green manure, and as a forage crop. In home gardens the paayap is raised for its green peas and pods for the table. Because of its agricultural uses and economic utility the paayap merits the attention of plant breeders and geneticists in efforts for its improvement.

The present work was undertaken to study the inheritance of the flower, seed-coat, and pod characters of cowpea in connection with an attempt to produce and develop a hybrid that would combine the desirable characters of both the imported and the native Philippine varieties. It became apparent in the course of the experiments that certain phenomena observed in this common plant offer a clear illustration of the laws of heredity.

[1] Experiment Station, College of Agriculture contribution 1037. Read before the Los Baños Biological Club January 24, 1935, and the Third Philippine Science Convention February 26, 1935.

This paper presents a description of the first hybridization work in this leguminous crop and an account of the mode of inheritance of factors affecting the colors of flower, seed coat, and pod, as well as the agronomic value and general hybrid behavior of the crosses produced.

The experiments described herein were begun in January, 1932, and were closed in January, 1935. The experimental cultures were conducted in the plant-breeding nursery and in the breeding plots on the experiment-station farm of the Department of Agronomy, College of Agriculture, University of the Philippines.

MATERIALS AND METHODS

Varieties of cowpea used.—The cowpea varieties differ in several agronomic characters, such as growth habit, size, prolificacy, and disease resistance. In color of seed coats they may be either variously blotched, speckled, and mottled or unicolored. The unicolored types are red, buff, black, grayish blue, creamy white, or white. The varieties used in these experiments, the New Era and the White Paayap, fall under the unicolored groups, and possess contrasting colors of flowers and seed coats.

The White Paayap is supposedly an indigenous variety of cowpea, which has yellowish or creamy white flowers and seed coats. It is a hardy, although not prolific, cowpea and possesses desirable culinary qualities, such as finer texture of pods and a smaller amount of fiber than the New Era variety.

The New Era variety, according to available records in the Department of Agronomy, is one of the several cowpeas introduced at this college in 1912 from the United States Department of Agriculture. It proved to be the only successful introduction. The seed coat is deep blue with innumerable minute blue specks on a gray background. It is an erect bushy plant, rarely having prostrate branches like the White Paayap variety. The flower is pale purple. New Era is an earlier flowering and maturing variety than the White Paayap. Although a prolific variety, it does not find favor as a vegetable, for the green pods are more hairy and fibrous than those of the other varieties.

Test and selection of parent varieties.—To insure the purity of the parent plants used in this work, preliminary tests were made to isolate pure races of both the White Paayap and New Era varieties. These tests were made by planting and harvesting

the two varieties in two separate lots for two seasons. The two varieties were grown very far apart; one, the New Era variety, was grown near the border fence of the plant-breeding nursery back of the agronomy main building, and the White Paayap variety was grown on one of the lots on the experiment-station farm. This procedure was adopted to minimize, if not entirely avoid, accidental mixture arising through natural cross-pollination. No other cowpeas were grown in the immediate vicinity of the lots where the two varieties were grown. In the first culture, the seeds of both varieties were planted January 4, 1932, and the pods harvested March 20 to April 27, 1932. To insure the use of one-line parentage, only pods gathered from one plant were grown in the next planting. The seeds from the first culture were sown June 8, 1932, and the pods harvested October 14 to 22, 1932. The uniformity observed in the color of the seeds and flowers served as a criterion of the apparent purity of the parental varieties tested.

Planting and flowering of parent varieties.—The seed materials intended for parent types were taken from the harvest of the second culture and both grown in the breeding plots of the experiment station. In order that the flowering periods of the two varieties would coincide, the New Era, the earlier of the two varieties, was planted later than the White Paayap. The planting was as follows:

Variety.	Date of planting.	Date of flowering.
White Paayap	July 25, 1933	October 15 to 20, 1933.
New Era	August 1, 1933	September 19 to October 27, 1933.

Technic of crossing.—Of the legumes with hermaphroditic flowers the cowpea is one of those with the largest blossoms. Its flower has ten stamens and one pistil inclosed in one floral envelope. In cross-pollination work with the cowpea, therefore, emasculation is necessary; this should be done at the bud stage. Preliminary observations are necessary to judge the age of the bud, when its own pollen has not yet been shed. The cowpea is a naturally self-fertilizing plant where dehiscence may even be completed before anthesis takes place. An unopened flower bud is triangular in form. To emasculate, a flower bud is held between the thumb and forefinger with its keel side at the top, then

a needle is run along the ridge where the edges of the petals unite. A slit is made a little below the keel, exposing the ten unexpanded stamens. With a pair of small forceps the filaments of the stamens are pulled out. They are counted as they are removed to make certain that none is left. The emasculated flowers are inclosed in a waxed or paraffine paper bag, or sometimes only covered with a leaf folded once and secured in position with a pin or a little splinter like a toothpick. In these experiments emasculation was sometimes accompanied by pollination on the same day or, if not, pollination was done on the following day. When emasculation and pollination were done simultaneously, the operations were performed at any time between 9 and 11 o'clock in the forenoon. When the flowers were emasculated in the afternoon, between 2 and 4 o'clock; pollen was applied the following morning. In all cases the parental types involved in the mating had been previously bagged.

The success or failure of artificial pollination was indicated by the appearance of the cross-fertilized flowers and by their adherence to the plants for some time. Unsuccessful fertilization was indicated by the falling off of the flowers as early as twelve hours after pollination. Generally, after a lapse of forty-eight hours after pollination, a small green structure of the pod became evident, as an indication of the successful setting of the pods.

Culture of Vigna hybrids.—The cross-pollinated seeds and their subsequent generations were planted and harvested as follows:

Seed material.	Planted.	Flowered.	Harvested.
F_1 hybrid	Dec. 2, 1933	Jan. 6, 1934	February to March, 1934.
F_2 hybrid	July 6, 1934	Aug. 10, 1934	September to October, 1934.
F_3 hybrid	Nov. 18, 1934	Dec. 27, 1934	January 5, 1935.

DISCUSSION AND RESULTS

Cross-pollination of cowpeas.—In Table 1 are shown the results of artificial crossing of cowpeas. At least 40 per cent of the flowers mechanically treated and artificially pollinated set pods. This is a fair percentage of success, considering the

TABLE 1.—*Results of cross-pollinating New Era and White Paayap varieties of cowpeas.*

Parental types.	Date of pollination.	Flowers treated.	Harvested.	Pollinated pods harvested.	
					Per cent.
White Paayap × New Era	Oct. 21, 1933	6	Nov. 15, 1933	6	100
Do	Oct. 23, 1933	9	Nov. 18, 1933	7	77
Do	Oct. 23, 1933	10	Nov. 18, 1933	4	40
New Era × White Paayap	Oct. 22, 1933	9	Nov. 14, 1933	5	55
Do	Oct. 26, 1933	6	Nov. 27, 1933	3	50
Do	Oct. 27, 1933	12	Nov. 29, 1933	5	42

weather and climatic conditions, such as unexpected rainfall and cooler days, which prevailed during the course of pollination experiments. The difficulty met with in synchronizing the flowering accounted for some low percentages of success in pollination. In these experiments it was observed that while one variety was at its height in flowering the other had passed the midperiod of its blooming. The pods harvested in the initial pollination work gave about ninety-eight plants for first-generation planting. In general, it may be stated that the cowpea is quite suitable material for hybridization because of the convenient size of its flower for hand manipulation.

Inheritance of flower color.—As mentioned elsewhere, the two varieties, White Paayap and New Era, possess contrasting colors, and offer suitable material for observation of hybrid and other genetic phenomena. The first-generation hybrid plants of the cross New Era and White Paayap were all purple-flowered. These F_1 purple-flowered plants, when pollinated inter se, gave in the F_2 generation only two phenotypic flower colors. Table 2 shows the segregation of flower colors in the F_2 hybrid population. Of the 478 plants in the whole population, 365 were purple-flowered and 113 white-flowered. The segregation suggests a monohybrid Mendelian ratio of 3:1. However, the goodness of fit of the observed ratio was tested not only for the 3:1 ratio but also for the dihybrid ratios 13:3 and 9:7, and the trihybrid ratio 37 : 27. After calculating the expected numbers of individuals, deviations, and probable errors, and testing the closeness of fit, it was concluded that the purple flower of the New Era is dominant to the white flower of the White Paayap and the segregation observed follows a simple Mendelian

TABLE 2.—*The Mendelian segregation of purple and white flowers in an F_2 Vigna hybrid population.*

Factorial basis.	Ratio.		Plants.					
	Observed.	Expected.	Observed.		Calculated.		Deviation.	Probable error.
			Purple.	White.	Purple.	White.		
Monogenic (normal)...	3.05 : 0.95	3 : 1	365	113	385.5	119.5	6.50	6.39
Digenic (modified).....	12.24 : 3.76	13 : 3	365	113	382.0	96.0	17.00	5.76
Do.....	12.24 : 3.76	9 : 7	365	113	269.0	209.0	96.00	7.32
Trigenic (modified)....	48.80 : 15.20	37 : 27	365	113	260.7	217.3	104.30	7.28

monohybrid ratio (Plate 1). The flower-color segregation herein reported found corroboration in the work of Harland,(1) who concluded that the F_2 segregation of flower color in cowpea was rather simple. He reported that in the crosses dark × pale, the F_2 segregation was the simple Mendelian one of 3 dark to 1 pale and concluded that these colors constitute an allelomorphic pair. This was also true in the cross dark × white. Harland's results of the cross pale × white were, however, explained by the assumption that the flower color is due to interaction of two factors.

Inheritance of seed-coat color.—The New Era seed coat, although characterized by minute specks on a dark gray background, is considered unicolored, for the deep blue predominates, appearing as a solid blue color. The White Paayap seed coat is creamy or yellowish white. For convenience the New Era seed-coat color is described as grayish blue or blue, and that of White Paayap as white. The F_1 plants of the original cross were all blue. In the F_2 population the seed-coat colors segregated into three phenotypes; blue, brown, and white. Of the 282 individuals, 165 were blue-seeded, 29 brown-seeded, and 88 white-seeded (Table 3). The situation appears different from that which had been observed in flower-color segregation. The calculated number of the phenotypes on the basis of two-factor inheritance, with a ratio of 9 : 3 : 4, closely approximates the blue and white classes, with slight deficiency in the brown class. The observed segregation was not compared and the closeness of fit tested with segregating ratios on the basis of more than two factors. Assuming that two genes are involved in the inherit-

TABLE 3.—*The Mendelian segregation of seed color in an F_2 Vigna hybrid population.*

Family.	Plants.	Color of seeds.	Total.	Calculated.	Ratio.		±E
					Expected.	Calculated.	
PWSB (1)	105	Blue	165	158.6	9	9.37	0.3372
PBSB (1)	60						
PWSB (2)	15	Brown	29	52.8	3	1.65	0.2698
PWSB (3)	14						
PWSB (4)	19	White	88	70.6	4	4.98	0.2630
PWSW	12						
PBSW	31						
PBSB (2)	26						
Total	282		282	282.0	16	16.00	

ance of seed color the theoretical considerations of the cross would seem to be as follows:

B, basic factor for pigmentation; *b*, absence, and recessive factor of *B*; *C*, modifying factor, which in the presence of and reacting with *B*, would give blue; *c*, absence of *C*, reacting with *B*, would give brown. The interaction of genes *B* and *C* would give the following phenotypic expression: *BC*, blue; Bc, brown; *bC* and *bc*, white.

In the above assumption the phenotypic proportion of 9 blue : 3 brown : 4 white appears to be sufficiently fulfilled to warrant the statement that the seed-coat color segregation observed in these experiments is governed by interaction of two genes (Plate 1). In this connection it may be mentioned that Harland(2) working with several colored cowpea varieties reported the following:

(*a*) Red × white. F_1 buff; segregating in F_2 into 9 buff : 3 red : 4 white.
(*b*) Black × white. F_1 black; segregating in F_2 into 9 black : 3 buff : 4 white.
(*c*) New Era × black. F_1 black; segregating in F_2 into 3 black : 1 New Era.
(*d*) New Era × white. F_1 New Era; segregating in F_2 into 9 New Era : 3 buff : 4 white.
(*e*) Black × buff. F_1 black; segregating in F_2 into 12 black : 3 buff : 1 red.

From the foregoing consideration it can be deduced that certain allelomorphic pairs of seed-coat colors are monogenic in inheritance while other color allelomorphs are digenic or bifactorial in heredity. The cross New Era × white, where F_2 segregation into 9 New Era : 3 buff : 4 white occurred, is similar in nature to the inheritance of seed-coat colors of the White Paayap × New Era cross here reported. The results of both crosses indicate that two factors are involved in seed color and follow a dihybrid segregation.

Relation between seed and flower colors.—An interesting aspect of correlated variability was observed in regard to the color of seed and color of flower. In the study of flower-color segregation, observation was extended to corresponding color of seed coats. Table 4 shows the relationship between these two char-

TABLE 4.—*The relationship of flower and seed colors in an F_2 Vigna hybrid population.*

Individuals.	Flower pigmentation.	Seed color.
165	Purple	Blue.
29	Do.	Brown.
88	White.	White.

acters. It was noted that purple-flowered plants developed colored seeds that were either blue or brown and the white-flowered plants formed white seeds. Apparently there was definite correlation between the occurrence of anthocyan in the flowers and the production of seed-coat color. This association was in accord with the constant correlations between blossom colors in the colors of seed coats in many varieties of beans as reported by Shaw,(4) who found that white or eyed bean varieties are always white-flowered or light pink-flowered, while the black wax varieties are always pink-flowered. Spillman,(5) who made some earlier observations on the inheritance of seed-coat color in *Vigna*, found that all varieties of cowpeas having white or cream-colored seeds have white flowers and are devoid of anthocyan in stems and leaves. The genetical mechanism of this association, according to Spillman,(5) may be visualized as follows: "The flower color which is due to an anthocyan, and the anthocyan in stems and leaves are dependent on two Mendelian color factors, one of which, apparently an enzyme, is the general factor for color in the seed coat of the cowpea. The other is the special factor for black which, when added to a variety having

coffee-colored seeds, converts the seed to black." The conclusions of Spillman, in so far as they relate to association between seed coat and flower colors, are applicable to the observation herein reported. Although in this investigation no information was obtained on the distribution of anthocyan in the stems and leaves resulting from gene action affecting flower and seed colors, the relationship between the colors of flower and seed appears to be well established.

Variability and heredity of pod color.—In cowpea varieties the matured pod showed variations in color. This color may be either dark brown, black, or yellowish white. In the hybrid population the pod color showed indication of simple Mendelian inheritance. In Table 5 it can be noted that all families

TABLE 5.—*The segregation of pod color in an F_2 Vigna hybrid population.*

Parental types.		Progeny.		Genetic behavior.
Family.	Pod color.	Individuals.	Pod color.	
PWSB (1)	White	15	White	Homozygous.
PWSB (2)	do	11	do	Do.
PWSW (1)	do	9	do	Do.
PBSB (1)	Black	15	do	Heterozygous.
		16	Black	
PBSB (2)	do	19	do	Homozygous.
PBSB (3)	do	22	do	Heterozygous.
		7	White	
PBSW (1)	do	29	Black	Homozygous.
PBSW (2)	do	18	do	Do.
PBSW (3)	do	28	do	Do.

having white pods produce white pods, while those having black pods either breed true to type, or segregate into black and white types. This merely suggests that the black-podded type behaved as either a homozygous or heterozygous dominant trait, while the white-podded type proved to behave as a recessive character. Family PBSB (1) segregated into 16 black and 15 white, which was very close to a 1 : 1 ratio. On the other hand, the family PBSB (3), which segregated into 22 black and 7 white, approximated a 3 : 1 ratio. All white-podded families PWSB and PWSW, however, produced all white-podded progeny. These true breeding and segregating tendencies of pod color are perhaps explicable on one-factor difference. The black type segregating into 1 black and 1 white may be assumed to be a cross

of heterozygous dominant and homozygous recessive *Bb* × *bb*, giving in the next generation 50 per cent *Bb* and 50 per cent *bb*. The black type segregating into 3 black and 1 white may be assumed to be a selfed heterozygote *Bb*, which should give 75 per cent black (25 per cent *BB* and 50 per cent *Bb*) and 25 per cent *bb*, which is white. Since no black pod appeared in any of the white-podded families, the recessive behavior of the white-pod character seems to be fully demonstrated. Harland(2) reported that the purple color of pod was dominant to its absence or nonpurple class, but the heterozygous lines segregated into a 4 : 1 ratio showing a marked deficiency of the recessive. This marked deficiency in the expected number of recessives led to the conclusion that more than one factor may be involved. Harland then concludes that, while the exact mode of inheritance of purple pod is not fully elucidated, it may be assumed meanwhile that one main factor, *P*, is responsible for the purple pod. It may be remarked here that Harland's purple pod color corresponds to the black pod color referred to in the present discussion, for both the colors apply to the New Era cowpea. The concept that one main factor is responsible for pod coloration appears to be substantiated in the present investigations where 1 : 1 and 3 : 1 segregations were observed.

Linkage relations.—The haploid chromosome number in *Vigna sinensis* Endl. is 12, as given by Kihara et al.(3) and Tschechow and Kartaschowa.(6) This would mean that the maximum linkage groups that could be established in this species would not exceed 12. The present work seems to indicate that a genetic linkage exists between the genes for flower color and seed-coat pattern. It was pointed out that all purple-flowered plants were either blue- or brown-seeded while all white-flowered plants were white-seeded. Furthermore, the genes for white flowers and those for white seeds seem to be closely linked, for in no case did a plant appear showing crossovers; that is, individuals with purple flowers and white seeds or individuals with white flowers and blue seeds. Harland(2) found the genes for black pattern of seed coat, purple pod, and New Era pattern of seed coat linked together, with the genes for black pattern showing repulsion on a basis probably higher than 1 : 15, and the genes for black pattern of seed coat and those for purple pod showing repulsion probably on a basis higher than 1 : 7. In the present experiments the apparent linkage between the genes for pod color and seed-coat colors should be very loose, for the relative distribution

that would account for their crossing over or repulsion was in order to simulate independent segregation in inheritance; for in the hybrid population were noted families with white pod-blue seeds, white pod-white seeds, black pod-blue seeds, black pod-white seeds, black pod-brown seeds, and white pod-brown seeds, occurring almost in equal proportions.

Agronomic features of cowpea varieties and their hybrids.—The practical value of hybridizing cowpeas is determined largely by the possibility of securing desirable segregates in the F_2 generation. In agronomic investigations yield is of major interest. Yield is here used with special reference to number of pods produced per plant and number and weight of seeds contained in each pod.

Comparisons of the parental and F_1 and F_2 populations were made on the basis of the mean, the range, and the variability as measured by Weinberg's(7) formula. This formula was adopted because it represents not only a rough measure of the skewness and range of distribution, but also gives an abstract number that is not affected by the magnitude of the mean as is the coefficient of variability.

A comparison of the production of pods per plant of the parental varieties and F_1 and F_2 populations of the hybrids is given in Table 6. The New Era variety and F_1 hybrid population

TABLE 6.—*The comparison of F_1 and F_2 populations with their parent varieties in number of pods per plant.*

	Range		Mean number of pods per plant.	W
	Minimum.	Maximum.		
White Paayap	3	27	9.96±0.89	0.704
New Era	3	33	12.24±1.14	0.607
F_1 hybrid	3	33	10.62±1.03	0.680
F_2 hybrid	3	31	11.00±0.93	0.670

showed a similar range in the number of pods produced per plant. The White Paayap proved to be a lower producer of pods than the New Era, whereas the F_2 hybrid segregate was almost intermediate between the two parents. The maximum variate of F_1 was higher than the maximum of the White Paayap parent but equal to that of New Era's maximum. That of the F_2 segregate was also higher than that of the White Paayap, but a little lower than that of the New Era's. The New Era

cowpea, with a mean of 12.24 ± 1.14 pods per plant, was a heavier producer than the White Paayap, which gives a mean of 9.96 ± 0.89 pods per plant. The F_1 hybrid produced 10.62 ± 1.03 pods per plant, which is a little higher than the lower parental type, but lower than the higher parental type. The F_2 segregate, with a mean of 11.00 ± 0.93 pods per plant, fell just between the means of the parental types. Statistically considered, however, the mean difference was not significant.

The variability relationships in number of pods produced per plant of the parental and hybrid types appear to agree quite closely. The White Paayap parent exhibited a degree of variability a little higher than the New Era parent and almost equal to those of the F_1 and F_2 populations.

The number of seeds contained in each cowpea pod refers to number of sound seeds; that is, undeveloped or aborted seeds are excluded. If the number of pods and size of seed were constant, the yield per plant would be dependent upon the number of seeds produced per pod. An increase in the number of seeds produced per pod would tend to increase plant production. The variability in number of seeds per pod as determined in the parental and F_2 hybrid segregate types is shown in Table 7.

TABLE 7.—*The comparison of an F_2 hybrid-brown segregate with its parents in number of seeds in each pod.*

Variety.	Range.		Mean number of seeds.	W
	Minimum.	Maximum.		
White Paayap	4	18	13.65±0.144	0.756
New Era	4	21	13.90±0.172	0.740
Hybrid Brown	3	20	13.44±0.178	0.670

In this determination data were not obtained on the F_1 hybrid type, for the comparison was made between the parent varieties and the F_2 hybrid, brown-seeded segregate, which was considered a novel type, or a new variety. The White Paayap parent had a range of 4 to 18 seeds per pod with a mean of 13.65 ± 0.144; the New Era variety, a range of 4 to 21 with a mean of 13.90 ± 0.172; and the F_2 hybrid segregate, a range of 3 to 20 with a mean of 13.44 ± 0.178. Statistically treated, the yield of the hybrid compared favorably with that of either parent variety, especially when the number of seeds produced per pod was con-

sidered. The variation in size of seeds as measured by the average weight of ten seeds is shown in Table 8. The average weight

TABLE 8.—*The comparison of an F_2 hybrid-brown segregate with its parents in weight of ten seeds.*

	Range.		Mean weight of ten seeds.	W
	Minimum.	Maximum.		
	g.	g.	g.	
White Paayap	0.3	1.5	0.788±0.025	0.825
New Era	0.5	1.5	0.936±0.022	0.740
Hybrid Brown	0.2	1.5	0.978±0.023	0.530

per ten seeds of White Paayap was 0.788 ±0.025 gram; New Era, 0.936 ± 0.022; and the F_2 hybrid-brown segregate, 0.978 ± 0.023. The Hybrid Brown seeds clearly weigh more than either of the parents. The variability relationship for number and weight of seeds appears to be constant. For these two characters the Hybrid Brown exhibits invariably the least degree of variation. The White Paayap in both cases excels to a slight degree the variation shown by the New Era. Biometrically the difference between the mean of New Era and White Paayap and that of Hybrid Brown and White Paayap was significant. Therefore, the Hybrid Brown cowpea, in so far as weight of seeds is concerned, constitutes an improvement on the White Paayap variety.

The isolation of pure race of the hybrid was tested by sowing a random sample of seeds from its five families November 18, 1934. Flowering commenced December 27, 1934. The pods matured January 5, 1935. Of the five families of brown-seeded hybrid four, which proved to be the homozygous genotype of brown-seeded type, produced all brown-seeded plants. One family segregated into brown- and white-seeded progeny. No statistical counts of brown- and white-seeded types were made, for the appearance of brown-and-white biotypes is taken as a confirmation of the action of the genes assumed in the inheritance of seed-coat pattern. Since homozygous lines of Hybrid Brown were already identified by breeding, the multiplication of this Hybrid Brown type would merely consist of planting them on a large scale. The hybrid type merits testing to prove whether or not it is as hardy as the White Paayap parent and as prolific as

the New Era. For culinary purposes it would seem that the amount of anthocyan in the seeds counts as an advantage, for this would lessen the colored fluid that darkens the water when the peas are boiled. The isolated Hybrid Brown represents the hardiness and habit of growth of the White Paayap parent and the prolificness and flower color of the New Era. The seed-coat color is neither one of the parental patterns and may be taken as the result of varietal hybridity.

SUMMARY OF CONCLUSIONS

This paper deals with the mode of inheritance of certain characters in the cowpea, *Vigna sinensis* Endl., and with the yield and culinary quality of the varietal hybrid produced. The experimental results may be summarized as follows:

1. The White Paayap, a native Philippine variety of cowpea, is a hardy plant, a favorite legume vegetable, and produces white flowers and white seeds. The New Era, an introduced variety, is a prolific plant and produces pale purple flowers and grayish blue or blue seeds. It is not as well liked as a vegetable as the White Paayap.

2. In crosses between these two varieties of cowpea, the inheritance of characters was as follows:

(*a*) Flower color is unifactorial in heredity. A cross between purple and white gave purple in F_1 and 3 purple : 1 white in F_2.

(*b*) Seed-coat color is bifactorial in heredity. A cross between blue and white gave blue in F_1 and segregated into 9 blue : 3 brown : 4 white in F_2.

(*c*) Pod color is unifactorial in heredity. The evidence was derived from a segregation of 3 black : 1 white, which was to be expected from a selfed heterozygote and from a segregation of 1 black : 1 white, which should result from a back cross of heterozygous dominant to a homozygous recessive.

(*d*) Linkage relations. It was shown that the genes for white seeds and white flowers and those of colored seeds and purple flowers were closely linked. The genes for pod color and seed color were suspected to be loosely linked. Other cases of linked characters showing repulsion have been reported.

3. The yields of F_1 and F_2 populations and the parental varieties were compared on the basis of mean, range, and Weinberg's measure of variability.

(*a*) The Hybrid Brown segregate proved a slightly better yielder than the White Paayap and ranks equal to the New Era parent.

(*b*) The Hybrid Brown cowpea selected from the hybrid population is as hardy as the White Paayap and as prolific as the New Era. The new cowpea merits testing with other cowpea varieties.

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ILLUSTRATION

PLATE 1

FIG. 1. Showing the inheritance of flower color in a cross between New Era and White Paayap cowpeas.

2. Showing the segregation of seed color in a cross between White Paayap and New Era. *a*, White Paayap (native); *b*, Hybrid Brown (new cowpea); *c*, New Era (introduced).

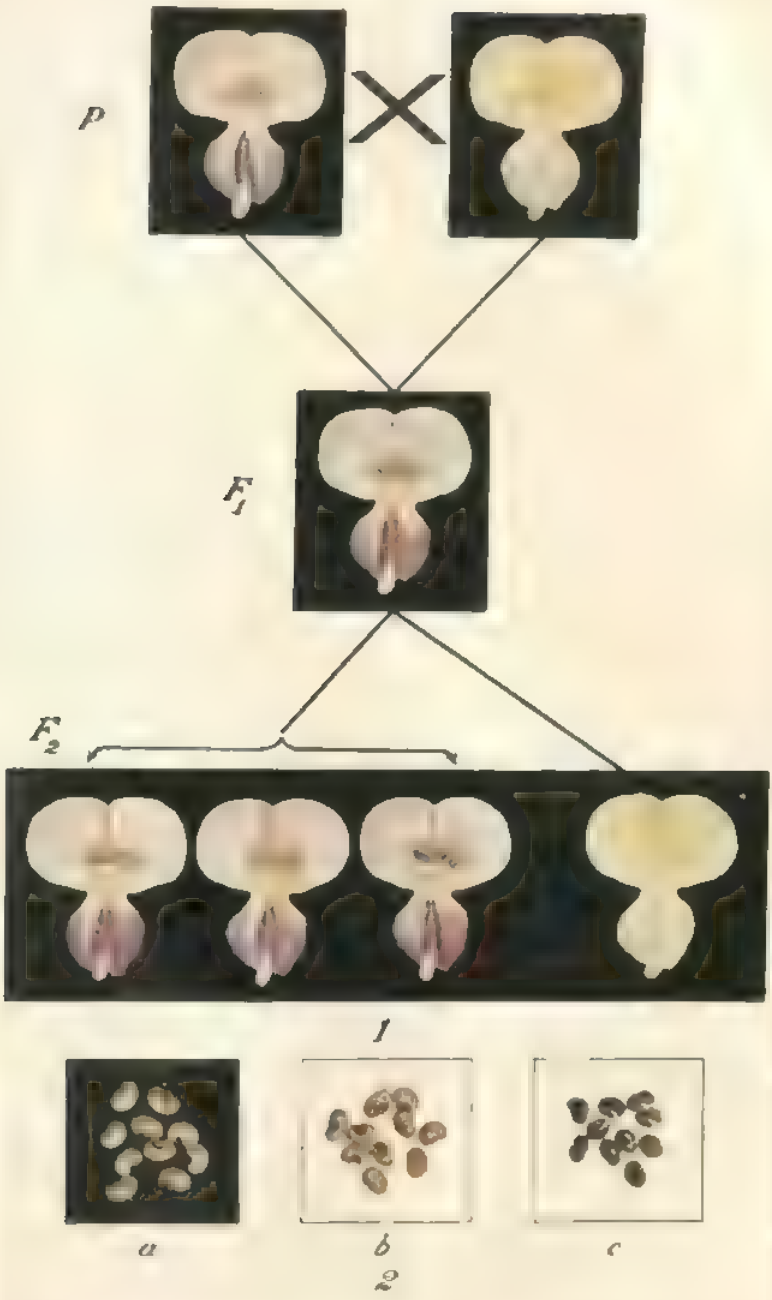

PLATE 1.

NOTES ON PHILIPPINE MOSQUITOES, III

GENUS CULEX: GROUPS LOPHOCERATOMYIA, MOCHTHOGENES, AND NEOCULEX [1]

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FOUR PLATES AND TWO TEXT FIGURES

Many of the species belonging to these groups are new, indicating that probably intensive collecting will bring to light other new forms.

Particular care has been exercised in the preparation of male terminalia for drawings. The phallosomes were drawn in their natural position; no cover glass was used to avoid distortion of shapes and natural arrangement of parts. When pressed or tilted a specimen will vary greatly from its natural appearance. It is sometimes difficult to keep a specimen in the desired position even when manipulated in thick mounting fluids; in such a case small pieces of broken cover glass used as supports will keep the organ at any angle wanted.

No species so far known of the Philippine *Lophoceratomyia* group possesses a true matted tuft on segment 9 of the male antenna, the scales forming the tuft being separated from one another from base to tip when examined in slide preparation.

The conclusions arrived at in naming as new those species which closely resemble forms found in other countries are the

[1] Submitted for publication February, 1935. Performed in the central laboratory of the malaria section, Philippine Health Service, Manila, of which Dr. Antonio Ejercito is chief. Grateful acknowledgments are here reiterated to Dr. Ejercito for his generosity and helpfulness; to Dr. Paul F. Russell, of the Rockefeller Foundation, who does not cease to be a source of help by correspondence and sending of materials from India where he is at present stationed; to Director Angel Argüelles, of the Bureau of Science, for extending to me the free services of the photographic division of his bureau; and to Mr. Domingo Santiago, of the School of Hygiene and Public Health, University of the Philippines, for lending me some of his specimens. To Mr. W. Garcia, artist of the malaria section, Bureau of Health, belongs the credit of inking all the drawings.

result of careful comparison of the specimens on hand with the descriptions and illustrations, particularly of the male terminalia, as given by various authorities. An attempt has been made to show as faithfully as possible the details of the male terminalia in our drawings.

The terms used in designating parts are adapted from those employed by Christophers and Barraud (1933–1934). Text figs. 1 and 2 show the more important parts of the male terminalia.

CULEX (LOPHOCERATOMYIA) MINDANAOENSIS sp. nov.

Type.—Male (lot M–x).

Cotype.—Male (lot M–y). Type and cotype are both in the collections of the Bureau of Health, Manila.

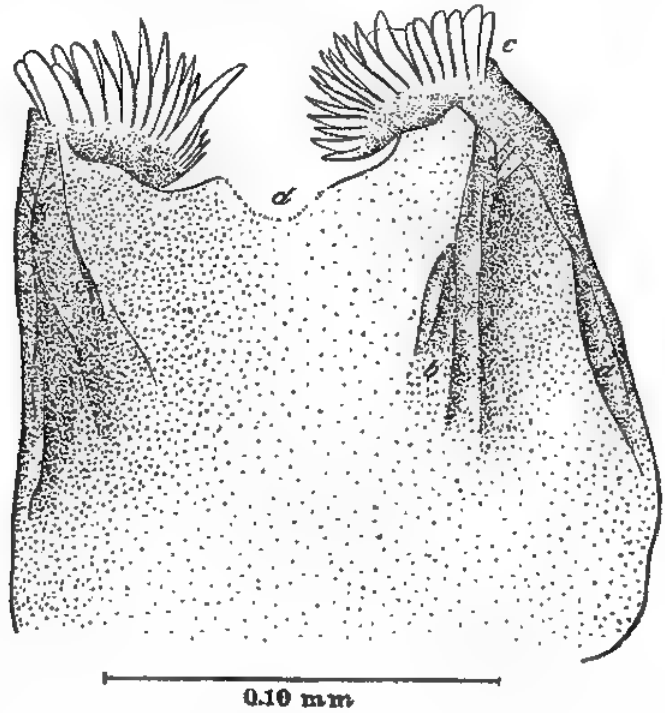

FIG. 1. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov., proctiger (anal segment), tergal view: *a*, paraproct; *b*, dorsal plate of proctiger (tergite X); *c*, crown of paraproct; *d*, anus.

Type locality.—Cotabato, Cotabato Province, Mindanao.
Collector.—F. E. Baisas.
Date of collection.—July 5, 1934.

Habits.—Larva breeds in fresh-water swamps; habits of adults unknown.

Distribution.—Known only from the type locality.

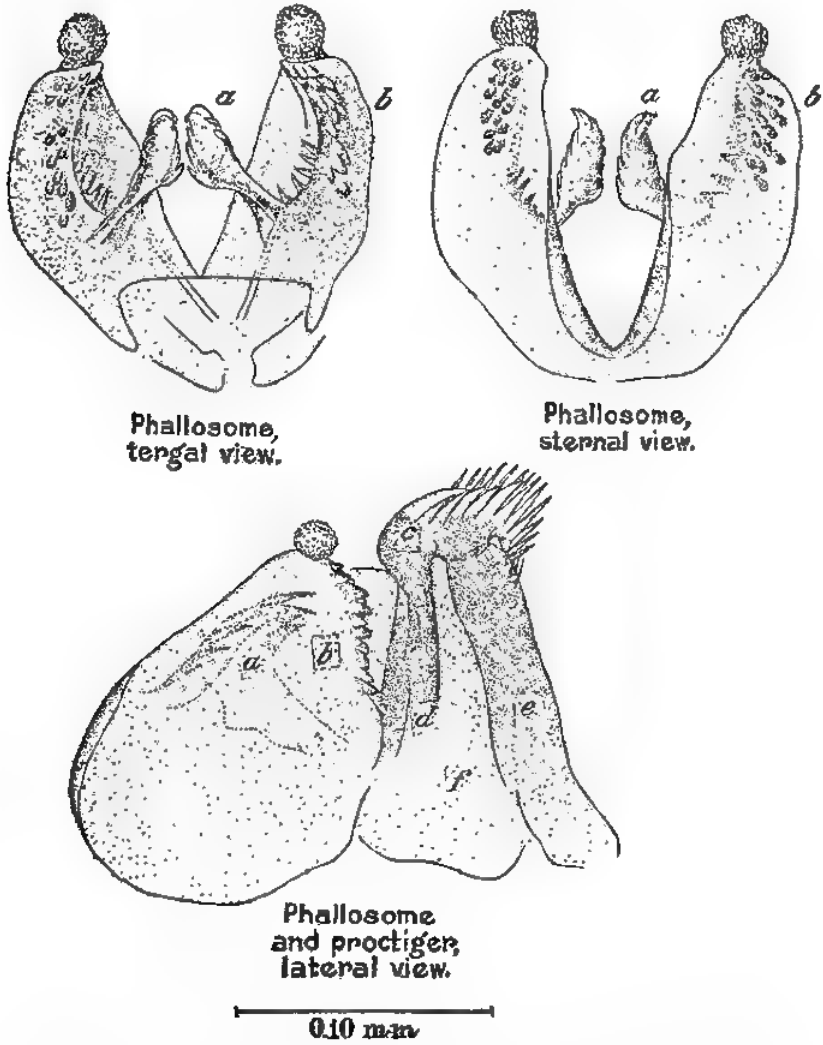

FIG. 2. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp nov., phallosome and proctiger; *a*, median process of phallosome; *b*, lateral process of phallosome; *c*, crown of parasproct; *d*, parasproct; *e*, dorsal plate of proctiger (tergite X); *f*, proctiger (anal segment).

Adult (*male*).—Head clothed with narrow, brown scales mixed with upright, forked ones on vertex and nape, except along eye margins where pale, broad scales are present. A patch of pale broad scales on either side to border of eyes. Proboscis a little

longer than front femur, dark brown. Palpi exceed the proboscis by more than half the length of the ultimate segment; the last two segments with very few hairs. Torus of antenna with a prominence; a few narrow scales of about equal length on segment 6; twisted and crumpled scales on 7 to 9, with a row of short straight scales on 8 and 9; a few somewhat thickened hairs on 10. Thorax with integument of mesonotum dark brown; scales narrow, brown; bristles darker. Scutellar scales narrow, brown. Postnotum and pleura pale brown. Wings dark-scaled.[2] Abdomen dark brown dorsally, paler ventrally. Legs mostly dark-scaled, undersides of femora pale; a portion of the basal dorsal surface of hind femora also pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a narrow leaf, one long bristle which is curved apically, one fairly long and three short curved blades, three still longer blades two of which are hooked at tips, the third twisted at apex. A row of about four slightly curved hairs on dorsal border of coxite. Phallosome with the lateral process much larger than the median process, possesses a bunch of short, blunt teeth forming a crown at apex; a few prominent, and some short, blunt teeth along its tergal border. The median process has prominent teeth projecting upwards when viewed from the tergal side. Paraproct with a crown of teeth, but having no basal arm (text figs. 1 and 2).

CULEX (LOPHOCERATOMYIA) NOLLEDOI sp. nov.

Type.—Male (lot R112–ax), and female (lot R112–ay).

Cotypes.—Seven males and 7 females. Types and cotypes are in the collection of the Bureau of Health, Manila.

Type locality.—Kolambugan, Lanao Province, Mindanao.

Collector.—Francisco Guinto.

Date of collection.—July 31, 1934.

Habits.—Larva breeds in rock holes in forest creeks; habits of adults unknown.

Distribution.—Known also from Limay, Bataan Province, Luzon (*United States Army Medical Department Research Board*).

Adult (*male and female*).—Separable from *mindanaoensis* only by means of male terminalia. Head with vertex and nape, excepting along eye margins, clothed with narrow, brown, flat,

[2] The relation of *af* to its petiole varies much among different individuals within a species and is of no practical value in identifying the members of the groups.

and upright, forked, dark scales; a row of pale, broad scales along eye margins broadening at sides. Proboscis a little longer than front femur. Palpi of female about one-sixth the length of proboscis; palpi of male exceeding the proboscis by about one-half the length of the ultimate segment, the last two segments having a few hairs. Torus of male antenna with a prominence; some narrow scales (hairlike in some individuals) of about equal lengths on segment 6; twisted scales on 7 to 9, with a row of short, straight ones on 8 and 9; a few short thickened hairs on 10. Thorax with integument of mesonotum dark brown, bristles also dark brown, scales paler. Scutellar scales narrow, brown. Postnotum and pleura brown. Wings dark-scaled. Legs mostly dark; about basal half of hind femur and undersides of all femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with three long curved blades, two of which are hooked at tips; three shorter curved blades, one spine curved at apex, and a narrow leaf. A row of six to eight long recurved hairs on dorsal border of coxite. Lateral process of phallosome with a crown of short blunt teeth at apex; some coarser teeth on its tergal border. Median process longer than that of *mindanaoensis*, but having no definite teeth.

CULEX (LOPHOCERATOMYIA) PACHECOI sp. nov.

Types.—Male (lot F150–7) and female (lot F150–5), with their larval skins.

Cotypes.—Five females with larval skins; 5 males and 7 females without larval skins.

Isotypes.—Four males and 3 females.

Type locality.—College of Agriculture, Los Baños, Laguna Province, Luzon.

Collector.—F. E. Baisas.

Date of collection.—February 2, 1935.

Habits.—Larva breeds in semistagnant edges of forest creeks; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (*male and female*).—Externally very similar to *fraudatrix* and *josephinex* (described below), from which it differs in the presence of two broad leaves on the subapical lobe of coxite of male terminalia. Head with vertex and nape, except along eye margins, covered with numerous upright, forked, dark scales, mixed with less numerous narrow, flat, brown ones. A row of pale, broad, flat scales along eye margins, broadening

at sides. Proboscis slightly longer than front femur, more than six times the length of female palpi, but exceeded by male palpi by more than the length of the last segment. Last two segments of male palpi with many hairs. A transverse row of stiff bristles at base of male proboscis underneath. A fingerlike process at base of each male palp. Torus of male antenna without a prominence; three or four long sharp-pointed scales on segment 6; twisted blades on 7 to 9, with two particularly broad but short ones on 8; about three long blades, abruptly tapering to a point near apices on 10; and about three thick hairs on 11. Thorax with scales and bristles of mesonotum dark brown. Scutellar scales narrow, brown; bristles darker. Postnotum brown, pleura much paler. Wings dark-scaled. Abdominal tergites dark, sternites less so. Legs mostly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with two broad leaves, three long curved blades, two of which are hooked at tips; three shorter blades, and one spine. A row of five or six hairs on dorsal border of coxite. Style gradually tapering towards apex. Phallosome with lateral process [3] a roughly conical, hollow structure bent towards apex; partly divided into two apically; no teeth.

CULEX (LOPHOCERATOMYIA) JOSEPHINEÆ sp. nov.

Types.—Male (lot R35–x) and female (lot R35), both of which are in the collection of the Bureau of Health, Manila.

Type locality.—Del Carmen, Pampanga Province, Luzon.

Collector.—F. E. Baisas.

Date of collection.—March 6, 1930.

Habits.—Larva breeds in a clear, vegetated river slew; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (*male and female*).—Very closely resembles *fraudatrix* but differs in male terminalia. Head with narrow, flat, brown scales confined to nape; upright, forked, dark scales more widely distributed. A line of pale, broad, flat scales along eye margins broadening at sides. Proboscis distinctly longer than front femur. Palpi of female less than one-sixth the length of proboscis; palpi of male longer than the proboscis by about one and one-half

[3] In *pachecoi*, *josephinea*, and *fraudatrix* what is called the lateral process may seem to correspond to the median process of *mindanaoensis*, *nolledoi*, and *mammilifer*, but since this is the only structure arising from the basal plate, the term lateral process is considered applicable.

times the length of ultimate segment; the last two segments of male palpi with many hairs. A small fingerlike process at base of each male palp. Torus of male antenna without prominence; a tuft of long scales on segment 6; crumpled scales on segments 7 to 9; about three long scales, which broaden a little toward the apices, but ending in sharp points, on 10. Thorax with integument of mesonotum together with mesonotal scales and bristles dark brown. Postnotum and pleura dark brown. Wings dark-scaled. Abdominal tergites and sternites dark. Legs mostly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a fairly large leaf, aside from the usual blades and bristle. A row of about four weak hairs on dorsal border of coxite. Style gradually tapers toward apex. Phallosome with lateral process bent tergolaterally towards apex; partly divided into three distally; a few knobs and a distinct branchlike projection at lower bend. Small sharp teeth on the sternal border basally. No median process.

CULEX (LOPHOCERATOMYIA) FRAUDATRIX Theobald (1905).

Habits.—Larva breeds in impounded, clear, vegetated spring water, and slow-flowing vegetated streams; habits of adults unknown.

Distribution.—Known only in Calauan, Laguna Province, Luzon (*D. Santiago*).

Adult (*male and female*).—(From specimens lent to me by Mr. D. Santiago.) Head with vertex and nape clothed with flat, narrow, dark brown scales and upright, forked, dark scales. A line of broad pale scales along eye margins broadening at sides. Proboscis a little longer than front femur; a transverse row of stiff bristles at base underneath. Palpi of female about one-sixth the length of proboscis, of male longer than proboscis by about the length of ultimate segment; the last two segments of male palpi with many hairs. A small fingerlike process at base of each male palp. Torus of male antenna without prominence; about four short hairs on each of segments 2 to 5; a tuft of long scales on 6; twisted blades on 7 to 9; about three blades on 10, and some thickened hairs on 11. Thorax with mesonotal integument, scales, and bristles dark brown. Pleura dark brown. Wings dark-scaled. Abdominal tergites dark, sternites paler. Legs mainly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a fairly large leaf; three long, curved, and several shorter

blades. A row of about four or five weak hairs on dorsal border of coxite. Style broadens distinctly towards apex. Phallosome with lateral process partly divided into two apically; roughly conical in shape, and bent towards apex; no teeth.

CULEX (LOPHOCERATOMYIA) INFANTULUS Edwards (1922).

Habits.—Larva breeds in vegetated, slow-flowing streams; habits of adults unknown.

Distribution.—Tungcong Manga, San Jose, Bulacan Province, Luzon (*Baisas*); known also from Calauan, Laguna Province, Luzon (*D. Santiago*).

Adult (male and female).—Resembles *minutissimus* very closely, but differs in male genitalic characters. Head with vertex and nape clothed with narrow, flat, pale brown, and upright, forked, dark scales; a border of broad, flat, pale scales along eye margins broadening at sides. Proboscis distinctly longer than front femur. Palpi of female about one-sixth the length of proboscis; of male longer than proboscis by about half the length of ultimate segment, the last two segments scantily haired. A small fingerlike process at base of each male palp. Torus of male antenna without prominence; two short scales on segment 8; about four longer scales on 9. Thorax with mesonotal integument and scales pale brown, bristles darker. Postnotum and pleura dark brown. Wings dark-scaled. Abdominal tergites dark brown with pale basal bands; sternites brown. Legs mainly dark, undersides of femora pale.

Male terminalia (see illustration).—Subapical lobe of coxite, without the usual broad leaf, with three fairly long blades curved at apices, and several shorter blades and spines. A row of short, widely separated hairs on dorsal border of coxite. Style tapering towards apex. Phallosome with lateral process a curved, hollow, conical cylinder, the sides roughly simulating a beehive. Basal process a simple plate.

CULEX (LOPHOCERATOMYIA) MAMMILIFER Leicester (1908).

Habits.—Larva breeds in forest creek; habits of adults unknown.

Distribution.—College of Agriculture, Los Baños, Laguna Province, Luzon (*Baisas*), and Iwahig, Palawan (*Baisas*).

Adult (male).—Head with vertex and nape covered with pale, brown, narrow, flat, and upright, forked, dark scales. A line of pale, broad, flat scales along eye margins broadening at sides. Proboscis longer than front femur. Palpi exceed the proboscis

by the length of ultimate segment, the last two segments scantily haired. Torus of antenna with prominence; some large scales of progressively increasing lengths on segment 6; crumpled scales mixed with short straight ones on 7 to 9; some short, thickened hairs on 10. Thorax with integument, scales, and bristles of mesonotum dark brown. Wings dark-scaled. Abdomen dark dorsally and ventrally. Legs mainly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with three long, curved blades, two of which are hooked at tips, one narrow leaf, one fairly straight blade, and three short spines. A row of six or seven strong, curved hairs on dorsal border of coxite. Style with a crest of short hairs near apex. Phallosome with lateral process having a crown of short blunt teeth at apex. A row of larger teeth along its tergal border. Median process fairly long, but without definite teeth.

CULEX (MOCHTHOGENES) YEAGERI sp. nov.

Type.—Male (lot R66–xyz).

Cotypes.—Three males. Type and cotypes in the collection of the Bureau of Health, Manila.

Type locality.—Iwahig, Palawan.

Collector.—F. E. Baisas.

Date of collection.—June 7, 1934.

Habits.—Larva breeds in forest streams; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (*male*).—Head with narrow, flat, pale brown scales confined to nape; upright, forked, dark scales scattered on vertex and nape; broad, flat, pale scales cover vertex and sides. Proboscis distinctly longer than front femur. Palpi less than one-sixth the length of proboscis. Thorax with mesonotal integument and scales pale brown. Wings dark-scaled. Abdominal tergites dark brown with narrow, pale, apical rings; sternites dark brown, the posterior ones with pale apical patches in continuation of the tergal rings. Legs mainly dark brown, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a broad leaf, several narrow blades, and spines. Style broad, short, forked. Phallosome with lateral process having a few short blunt teeth along the internal tergal border. No median process.

CULEX (MOCHTHOGENES) CHIYUTOI sp. nov.

Types.—Male (lot R33–xxz) and female (lot R33–xyz).

Cotypes.—Five males. Types and cotypes in the collection of the Bureau of Health, Manila.

Type locality.—Kolambugan, Lanao Province, Mindanao.

Collector.—F. E. Baisas.

Date of collection.—March 28, 1934.

Habits.—Larva breeds in tree holes; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (male and female).—Head with vertex and nape covered with narrow, pale brown, flat, and upright, dark and brown, forked scales; a patch of pale broad scales on sides to border of eyes. Proboscis much longer than front femur; palpi of both sexes about one-sixth the length of proboscis. Thorax with integument of mesonotum dark brown; scales narrow, brown; bristles numerous, strong, dark. Postnotum and pleura dark brown. Wings dark-scaled. Abdominal tergites dark, sternites a little paler. Legs mainly dark-scaled; hind femora of female entirely white underneath, dorsal surface white also from base to about middle of segment; undersides of all other femora also pale. Hind femora of male not so extensively pale dorsally as that of the female.

Male terminalia (see illustration).—Subapical lobe of coxite with two curved leaves, one of which is like a boat; a narrow curved blade and five smaller boatlike leaflets. Style simple. Phallosome with lateral process having a number of teeth on tergal border. No median process.

CULEX (MOCHTHOGENES) LAURELI sp. nov.

Type.—Male (lot R38–xx); in the collection of the Bureau of Health, Manila.

Type locality.—Malaybalay, Bukidnon Province, Mindanao.

Collector.—F. E. Baisas.

Date of collection.—April 4, 1934.

Habits.—Larva breeds along the vegetated edges of rapidly flowing streams; habits of adults unknown.

Distribution.—Known only from the type locality.

Adult (male).—Head with vertex and nape clothed with narrow, pale, flat, and upright, forked, dark scales. A line of pale, broad, flat scales on border of eyes broadening at sides. Proboscis longer than front femur. Palpi less than one-sixth the length of proboscis. Thorax with mesonotal integument and scales

brown; bristles not strong, dark brown. Wings dark-scaled. Abdominal tergites dark; sternites a little paler. Legs mainly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with three leaflets, one of which has strong serrations on one side; three fairly long curved blades, the broadest having flaps at tip; and a short spine. Style fairly long, forked. Phallosome with lateral process having some teeth along the tergal border. No median process.

CULEX (NEOCULEX) BREVIPALPIS Giles (1902).

Habits.—Larva breeds in forest streams; habits of adults unknown.

Distribution.—Known only from Limay, Bataan Province, Luzon (*United States Army Medical Department Research Board*).

Adult (*male and female*).—Head with vertex and nape clothed with narrow, pale, flat, and numerous yellowish, upright, forked scales. A patch of pale broad scales on either side. Proboscis longer than front femur. Palpi of female less than one-sixth the length of proboscis; of male about two-thirds the length of proboscis. Thorax with mesonotal integument and scales brown to dark brown; bristles numerous, dark, the majority aligned in two rows near the middle from anterior to posterior margins of mesonotum; others are grouped above wing roots. Scutellar scales narrow, dark brown. Pleura pale brown with indefinite pale patches. Wings dark-scaled. Abdominal tergites dark brown; sternites paler, particularly the terminal ones. Legs mainly dark, undersides of femora pale.

Male terminalia (*see illustration*).—Subapical lobe of coxite with a leaf, three long and three short blades curved at tips. Phallosome divided into two broadly conical lobes each having some blunt teeth on apical, internal, tergal border.

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ILLUSTRATIONS

Plate 1. Male Terminalia

Fig. 1. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov.; *a*, sternal view.
2. *Culex* (*Lophoceratomyia*) *nolledoi* sp. nov.; *a*, sternal view.
3. *Culex* (*Lophoceratomyia*) *pachecoi* sp. nov.; *a*, sternal view.

Plate 2. Male Terminalia

Fig. 1. *Culex* (*Lophoceratomyia*) *frandatrix* Theobald; *a*, sternal view; *b*, lateral view.
2. *Culex* (*Lophoceratomyia*) *josephinex* sp. nov.
3. *Culex* (*Lophoceratomyia*) *mammilifer* Leicester.

Plate 3. Male Terminalia and Male Antennæ

Figs. 1 and 2. *Culex* (*Neoculex*) *brevipalpis* Giles.
3 to 5. *Culex* (*Lophoceratomyia*) *infantulus* Edwards.
Fig. 6. *Culex* (*Lophoceratomyia*) *pachecoi* sp. nov.
7. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov.
8. *Culex* (*Lophoceratomyia*) *mammilifer* Leicester.
9. *Culex* (*Lophoceratomyia*) *josephinex* sp. nov.
10. *Culex* (*Lophoceratomyia*) *nolledoi* sp. nov.
11. *Culex* (*Lophoceratomyia*) *fraudatrix* Theobald.

Plate 4. Male Terminalia

Fig. 1. *Culex* (*Mochthogenes*) *chiyutoi* sp. nov.; *a*, sternal view; *b*, lateral view.
2. *Culex* (*Mochthogenes*) *yeageri* sp. nov.
3. *Culex* (*Mochthogenes*) *laureli* sp. nov.

Text Figures

Fig. 1. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov., proctiger (anal segment), tergal view.
a, Paraproct.
b, Dorsal plate of proctiger (tergite X).
c, Crown of paraproct.
d, Anus.
2. *Culex* (*Lophoceratomyia*) *mindanaoensis* sp. nov., phallosome and proctiger.
a, Median process of phallosome.
b, Lateral process of phallosome.
c, Crown of paraproct.
d, Paraproct.
e, Dorsal plate of proctiger (tergite X).
f, Proctiger (anal segment).

PLATE 1

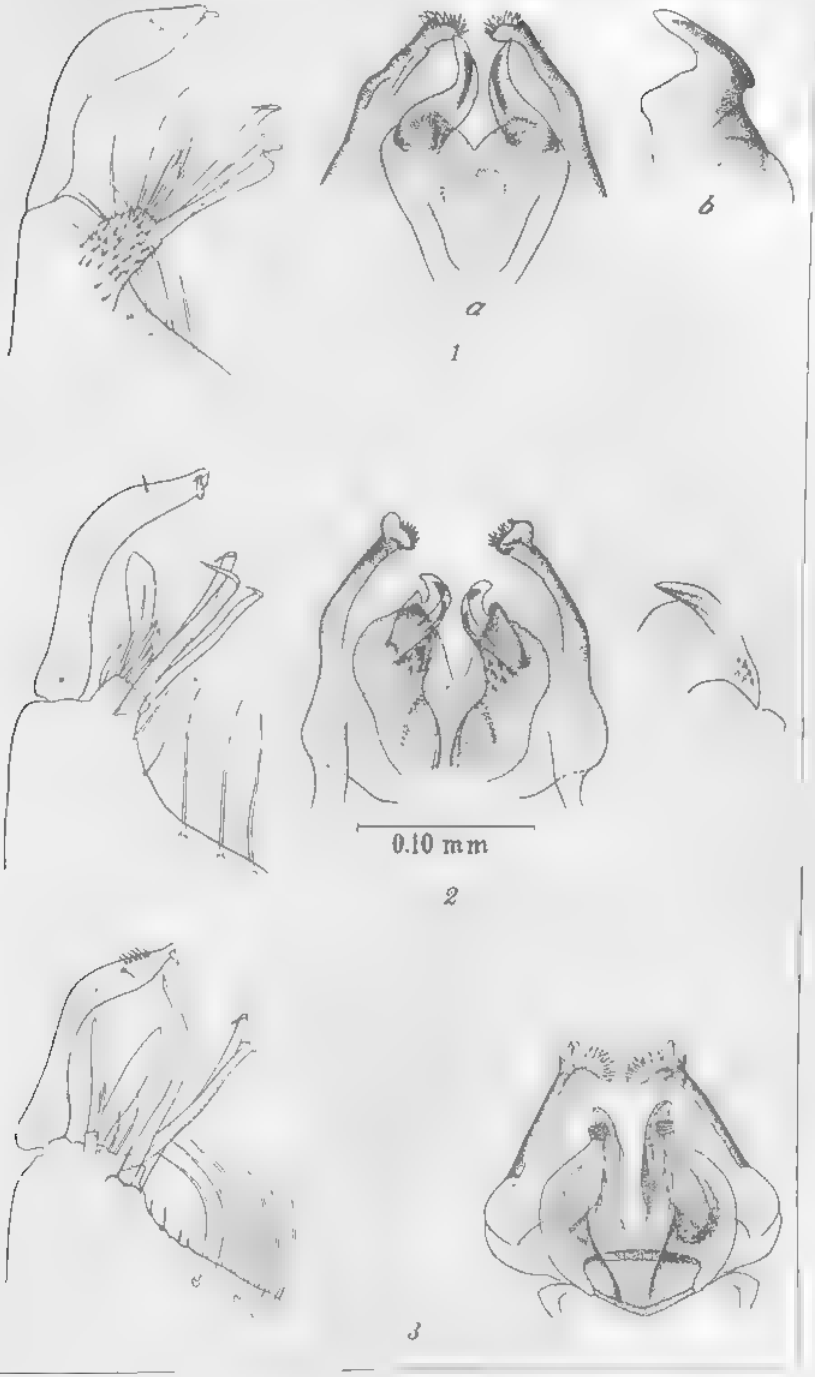

PLATE 2.

PLATE 4.

NEW SPECIES AND RECORDS OF LONGICORNS FROM FORMOSA (COLEOPTERA: CERAMBYCIDÆ)

By J. Linsley Gressitt

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The following descriptions of new species, synonymical notes, and new records are based primarily on material collected by the author during two trips to Formosa in 1932 and 1934, respectively. Previous contributions to the cerambycid fauna of Formosa, as well as Japan and the Loochoo Islands, were made by the author.[1] The author wishes to express his appreciation to Dr. E. C. Van Dyke, of the University of California, for his suggestions in the course of the preparation of the paper.

CERAMBYCINÆ

DISTENIINI

Genus NOEMIA Pascoe

NOEMIA INCOMPTA Gressitt sp. nov.

Extremely narrow, parallel-sided; dark grayish brown, nearly black; bases of legs pale; sparsely, but almost entirely, clothed with moderately short, suberect setæ; antennæ furnished with a row of long, equal, fine hairs on the inner side, which are not always visible.

Head directed anteriorly, constricted anterior to antennal insertions; maxillary palpi large, last segment fusiform; frons broad, concave, only slightly oblique to dorsal surface; eyes reniform, moderate-sized, posterior to insertions of antennæ, subemarginate anteriorly; vertex slightly concave in middle, but swollen at sides next to antennal supports, which are low; vertex and occiput minutely punctulate; ventral surface reddish brown, subglabrous. Antennæ (female?) one and three-fourths times as long as body, very fine, filiform; scape pedunculate, long, basal third narrow and curved, remaining portion swollen and fusiform; second segment shorter than broad; the remaining segments hardly appreciably diminishing in length or thickness;

[1] Pan-Pacific Entomol. 9: 163-170; Philip. Journ. Sci. 55 (1934) 379-386.

third to fifth segments very slightly thickened at extreme apices; clothed with a few very short hairs, and furnished internally with a row of long thin hairs which are generally hidden or lost. Prothorax nearly twice as long as broad at base, apex slightly narrower than base, constricted near base and apex, central portion hardly rounded above, furnished at each side with a broad-based tubercle with blunt apex; surface with dense, microscopic puncturation and also with a few, scattered, shallow punctures of larger size. Scutellum small, as long as broad, rounded posteriorly. Elytra long, narrow, subparallel, only slightly narrowed posteriorly; furnished with close, deep punctures, arranged in about ten irregular longitudinal rows, the rows divided by a few rather indistinct longitudinal ridges; apices slightly narrowed and rounded. Ventral surface sparsely punctate; coxæ and thoracic sutures amber-colored; first three abdominal segments subequal, diminishing slightly in length, fourth segment slightly shorter than fifth, which is slightly less than third. Legs relatively short, nearly black, the bases of femora testaceous; clothed with irregular light hairs; femora pedunculate and fusiform, anterior pair most swollen; tibiæ moderately straight; tarsi very short, first segment of fore and middle pairs slightly shorter than second and third segments combined, equal in the hind tarsi, last segment short.

Length, 11.25 millimeters; breadth, 1.8.

Holotype, probably a female, No. 50899, United States National Museum, taken by the author at Hassenzan, north-central Formosa, altitude 1,500 meters, June 25, 1934; and one paratype, of the same sex, taken by the author near Hori, central Formosa, altitude 600 meters, June 9, 1934, in the author's collection.

This species agrees fairly well in characters with the genus to which it is referred, which is centered in Madagascar but also has some species in the Indo-Malayan and Philippine subregions.

OEMINI

Genus OPLATOCERA White

OPLATOCERA OBERTHURI Gahan.

Oplatocera oberthuri GAHAN, Fauna Brit. Ind. 1 Ceramb. (1906) 108, fig. 43.

Female.—Large, sides subparallel, antennæ fine; light brown marked with darker brown and black; pronotum with two short

oblique oval black spots on center of disc which touch anteriorly, and a narrow black line along side just above lateral tubercle; elytra marked with two, interrupted, strongly oblique bands of dark brown, the first placed before the middle, consisting of two spots, the one narrow and long, beginning near the external margin and continuing to near middle, and the other obliquely oval, sublongitudinal, on disc away from suture, the second band more complete, its margin irregular, commencing near external margin behind the middle and extending into the last quarter to slightly nearer the suture than the first band; palpi, eyes, apices of antennal segments, particularly the first five or six, bases of trochanters and apices of coxæ, femora and tibiæ black; body except elytra and abdomen clothed with very short suberect golden hairs, longer on underside of antennæ, and blacker on head and prothorax, the latter with a somewhat silvery pubescent effect, elytra with the finest and most obscure white pubescence.

Head nearly as broad as long, concave between the eyes, granulose; frons, clypeus, and labrum very short; mandibles small; eyes oblique, deeply constricted, ventral lobe globular, dorsal lobe broadly oval. Antennæ one-fourth longer than body; rather fine, the first five or six segments thickened, funnel-shaped at apices, third to fifth segments finely toothed externally; scape cone-shaped, broadest at extreme apex, produced slightly externally; second segment barely broader than long; third segment twice as long as scape, one-fourth longer than fourth segment, fourth and succeeding segments diminishing evenly in length, the apical three subequal. Prothorax broader than long, acutely tuberculate at sides, deeply constricted near base, narrowly near apical margin; surface granulose. Scutellum small, triangular. Elytra together two and one-half times as long as broad, subparallel, slightly narrowed posteriorly; margins concave before middle; surface marked with four longitudinal costæ, the inner two commencing at base and uniting before apical quarter, the outer two arising behind shoulder, the fourth disappearing posteriorly and the third converging with the second near apex; apices narrowed, with the sutural angles nearly acute. Legs moderate, with the femora short; first segment of hind tarsi barely as long as following two segments united; claws small.

Male.—Elytra strongly narrowed posteriorly, apical margin black; prothorax larger, hardly constricted before lateral tubercles.

Length, female, 37 millimeters, male, 30; breadth, female, 10, male, 9.

A female taken by the author at Hassenzan, Formosa, altitude 1,250 meters, June 27, 1934; a male (antennæ missing) taken near Bukai, central Formosa, altitude 900 meters, June 14, 1934.

Habitat.—India (Sikkim, Darjeeling, British Bhutan); China (Szechwan Province); Formosa (central part).

Identical with a specimen in the collection of the California Academy of Sciences from Szechwan, China, compared with the type in the British Museum by E. C. Van Dyke. Hitherto unrecorded from China or Formosa.

CERAMBYCINI

Genus **HEMADIUS** Fairmaire

HEMADIUS OENOCHROUS Fairmaire.

Hemadius oenochrous FAIRM., Ann. Soc. Ent. France VI 9 (1889) 57 (Ngan-Hoei, China).

Neocerambyx stötzneri HELLER, Ent. Blätter 19 (1923) fig. 72 (China); PLAVILSTSHIKOV, Koleopt. Rund. 17 (1931) 195 (=*H. oenochrous*).

Neocerambyx mushaensis KANO, Trans. Nat. Hist. Soc. Formosa 18 (1928) 224 (Musha, Formosa).

A handsome, large species; glossy black, clothed above with dense, silky pubescence of a bright red color; dorsal surface of tarsi and latter half of antennæ silvery.

Habitat.—China (Tibet to Fukien Province); Formosa (Musha, Hori, Taiheizan, Rahau, and Hinokiyama).

Genus **PSEUDAEOLESTHES** Plavilstshikov

Pseudaeolesthes PLAVILS., Bestim.-Tabell. europ. Coleopt. 100 (1931) 73. Genotype: *Aeolesthes chrysothrix* (Bates).

Niphocerambyx MATSUSHITA, Journ. Fac. Agr. Hokkaido Imp. Univ., Sapporo 34 (1933) 244. Genotype: *Aeolesthes chrysothrix* (Bates).

PSEUDAEOLESTHES CHRYSOTHRIX (Bates).

Neocerambyx chrysothrix BATES, Ann. & Mag. Nat. Hist. IV 12 (1873) 152, female (Nagasaki, Japan); Linn. Journ. Zool. 18 (1884) 208, male (Tokyo).

Neocerambyx batesi HAROLD, Abhandl. Nat. Ver. Bremen 4 (1875) 295, male (Japan); LEWIS, Entomologist 26 (1893) 152 (=*chrysothrix* Bates).

Aeolesthes chrysothrix (Bates) AURIVILLIUS, Col. Cat. Ceramb. pars 39 (1912) 47.

Pseudaeolesthes chrysothrix (Bates) PLAVILS., Bestim.-Tabell. europ. Coleopt. 100 (1931) 73.

Niphocerambyx chrysothrix (Bates) MATSUSH., Journ. Fac. Agr. Hokkaido Imp. Univ., Sapporo 34 (1933) 244.

A narrow, elongate species; the elytra somewhat sculptured and clothed with a dense, golden or golden brown pubescence lying in different directions, which gives a strikingly variable appearance; antennæ of female slightly longer than body, those of male nearly two and one-half times length of body; prothorax subacutely tuberculate at sides; elytral apices subobliquely truncate and bidentate, the sutural tooth longer.

Habitat.—Japan (Honshu, Shikoku, and Kyushu); Formosa (Hori).

CALLICHROMINI

Genus CHLORIDOLUM Thomson

CHLORIDOLUM ACCENSUM (Newman).

Callichroma accensum NEWM., Entomologist 1 (1842) 246 (Manilla).

Large, highly variable in size; prothorax sharply tuberculate at side; elytra strongly narrowed posteriorly; head bluish green, antennæ violet; prothorax green with some violet tints above and with two approximate, slightly violet, black, triangular spots of velvet on center of disc, which together form an inverted equilateral triangle; scutellum bluish green; elytra frosted green, shiny vermiculose green near scutellum, with a velvety stripe of bluish green commencing near middle of base of each elytron, the two converging at first quarter and extending to apex along suture, and also a broader marginal stripe of velvety violet-blue to reddish violet extending from shoulder to apex; ventral surface silvery pubescent, the abdomen tinged with blue; legs red on fore and middle femora, except apices, basal half of hind femora and apical third of fore and middle tibiæ also red, remainder violet, except fore tarsi which are dull brown.

Two specimens in the author's collection taken on Botel-Tobago Island (Kotosho), east of the southern tip of Formosa, latitude 22° 5′ north, longitude 121° 35′ east, June 10, 1934, by Y. Izumi.

Habitat.—Philippines; Botel-Tobago Island (Kotosho).

This species is evidently common on the island, and has been misrecorded as *C. nympha* White.

CLYTINI

Genus AGLAOPHIS Thomson

AGLAOPHIS DECEMMACULATUS Gressitt sp. nov.

Narrow, laterally compressed; light, of a pale, cinereous color, each elytron marked with five black spots in four bands, the first band basal, of two spots, the next two bands close, and near the middle, the last before the apex; densely pubescent

except on spots; prothorax longer than broad, widest at apex, narrowed towards base.

Head vertical, densely clothed with light pubescence; frons quadrate; genæ granulose, their internal angles each with a node-like swelling; interantennal portion concave in middle and swollen at sides; occiput sunken; ventral lobe of eyes subglobular. Antennæ clothed with light gray pubescence and internally with moderate, flying hairs which become very scarce apically; equal in length to body; third segment moderately spined internally at apex, fourth segment hardly perceptibly spined; scape subcylindrical, apicomedially swollen, slightly arched; second segment two-fifths as long as scape, slightly swollen; third to fifth segments sightly swollen at apices; apical segments thickened; fourth segment two-thirds as long as third or fifth, which are subequal, sixth and seventh segments practically as long as third and fifth, succeeding segments slightly shorter. Prothorax narrow, broadest at apex; sides straight, vertical, not swollen; basal four-fifths as broad as apex; apex hardly narrower than head; dorsal surface greatly swollen, abruptly and vertically deflexed laterally; surface clothed with dense grayish green pubescence, which is sparse dorsally, showing granulose punctate surface. Elytra narrow, straight and flat dorsally, each with a narrow, longitudinal tubercle near base, strongly sloped at apices, sides strongly and vertically deflexed; apices transversely truncated, external angle armed with a strong spine, internal angle with a short tooth; surface clothed with dense grayish green pubescence except for five lacquerlike, black, subglabrous, subrugulose, punctate spots; deflexed portions sparsely clothed with pubescence; the first two spots basal, one on the shoulder, the other on the tubercle; third and fourth spots close, the former oblique, pointing posteriorly towards suture, placed slightly before middle, the latter transverse and medially placed, narrower; fifth spot one-fourth length from apex, subtransverse and rectangular; the last touching suture, the others not. Ventral surface clothed with light, silvery gray pubescence, except for anterolateral corner of metasternum, posterior edges of abdominal segments and base of first; first abdominal segment moderately long, second two-thirds as long as first and equal to fifth; third and fourth shorter; fore coxæ subglobular, prominent, intercoxal process much narrowed; mesosternal intercoxal process broad. Legs dark, clothed with light pubescence; trochanters and bases of femora reddish brown; femora moderately and fairly abruptly

clavate; fore and hind tibiæ with two short apical spines, middle pair with a single spine; tarsi two-thirds as long as tibiæ, first segment of middle pair equal to second and third segments combined, first segment of hind pair subequal to remaining segments combined.

Length, 9.7 millimeters; breadth, 2.8.

Holotype, a unique, in author's collection, taken at Hori, central Formosa, altitude 500 meters, October 19, 1933, by a native collector and sold to the author.

CLEOMENINI

Genus CLEOMENIDA Schwarzer

CLEOMENIDA PULCHELLA Gressitt sp. nov.

Small, narrow, parallel, setigerous, punctate; metallic green, the prothorax orange, with the basal constricted portion blackish green, the apical constricted portion blacker, tarsi brown beneath, submetallic above, antennæ with the scape metallic green, the rest brown with the second to fifth segments slightly tinged with green; clothed with long, erect, flying white hairs except on lateral portions of body and posterior half of elytra; antennæ, except two basal segments, furnished only with a row of hairs on the inner side, the hairs becoming scarcer posteriorly, the latter segments, except last, each with only a single apical hair.

Head narrow, broadest at eyes, moderately punctate except on neck, which is short and very slightly constricted; frons flat, broadest at bases of antennæ; clypeus and labrum narrow; genæ prominent; vertex broadly and shallowly concave between antenniferous tubercles, which are low, obtuse, and moderately distant; eyes with inferior lobes pear-shaped and superior lobes long and narrow, but distant. Antennæ (female) reaching to about the apical fifth of the elytra; the scape thick, bulb-shaped, thickest near the apex, not very narrow basally, the second segment similar in shape, third to fifth slightly swollen and globose at apices, remaining segments thickened gradually, but very slightly, towards apices, last segment blunt; second segment one-third as long as scape, scape two-thirds as long as third segment, fourth segment two-thirds as long as third and four-fifths as long as fifth, fifth to seventh subequal, eighth to eleventh shorter and subequal. Prothorax fairly twice as long as breadth at base, apex practically as broad as base, base three-fourths as broad as elytra at base; central portion swollen, nearly as broad

as elytra, subglabrous, reddish orange with faint lavender reflections, practically impunctate and very sparsely clothed with hairs above. Scutellum small, semicircular. Elytra narrow, flattened dorsally, rounded laterally, narrowed before middle; latter part as broad as base; margins concave; apices with both internal and external angles oblique, forming a blunt point in the middle. Underparts, except prothorax, metallic and punctate, ventral surface less so than lateral; first segment of abdomen slightly longer than second and third segments united. Legs with femora long, arched, very thin, pedunculate and clavate; fore femora swollen for more than the latter half of their length, middle femora swollen for less than half their length, hind femora swollen for the last quarter of their length, barely reaching beyond apex of abdomen; tibiæ shorter than femora; tarsi long, first segment of middle pair subequal to succeeding two segments united, first segment of hind tarsi one and one-half times as long as second and third united.

Length, 7.3 millimeters (7 to end of elytra); breadth, 1.1.

Holotype, a unique, probably a female, in the author's collection, taken at Riran, Formosa (east coast), latitude 23° 2′ north, altitude 250 meters, April 19, 1932, by the author.

This species agrees fairly well in structure with the genotype, *C. setigera* Schwarzer, also from Formosa, but differs from the latter in the smaller mandibles, thicker scape, less quadrate swollen portion of pronotum, more parallel elytra which are less narrowed posteriorly, less flattened dorsally, more rounded laterally, and less acute apically; also in having the femora swollen for shorter lengths and in the puncturation being more accentuated, the colors brighter, and the basal segments of the hind tarsi shorter.

LAMIINÆ

MONOCHAMINI

Genus MONOCHAMUS Guerin

MONOCHAMUS FLOCCULATUS Gressitt sp. nov.

Large and broad; blackish brown; surface uneven and clothed on elytra with many irregular areas of dense pubescence, giving the effect of many jet black or golden brown shiny spots, according to the angle of vision; a golden pubescent spot at middle of side of each tibia; entire body clothed with black pubescence and also very sparsely with single white hairs, one to each puncture on prothorax and elytra, more noticeable on ventral surface; tarsi ochraceous below.

Head with only a few strong punctures on frons, and some fine ones on labrum and bases of mandibles; frons subrectangular, slightly broader than high; clypeus very short, labrum large; antennal supports prominent; vertex strongly concave between them; occiput grooved medially; eyes in the shape of a curved gourd, grossly faceted. Antennæ (female) two-fifths longer than body, nearly naked; scape gradually thickened towards apex, cicatricized narrowly above; second segment broader than long, third segment one-third longer than scape or fourth segment; fifth to tenth segments subequal and slightly shorter than fourth, apical segment half again as long as tenth; third to seventh segments somewhat swollen at apices. Prothorax as long as broad, apex slightly narrower than base, base slightly more than half as broad as elytra at base; subacutely tuberculate at sides; surface punctate, very uneven, transversely impressed with a straight line near base and a curved line near apex, forming a depression beyond middle; disc with five swellings in the form of an inverted W, the middle three more prominent, the anterior two tuberculate and the medial one long, broadened posteriorly. Scutellum broader than long, rounded posteriorly. Elytra broadest at shoulders, slightly narrowed posteriorly, slightly more than twice as long as broad, apices subobliquely truncate with the sutural angles obtuse; surface with many irregular pubescent swellings and pits, deeply punctate basally, more finely posteriorly. Ventral surface impunctate; intercoxal process of mesosternum swollen and subvertical in front. Legs large; tibiæ strongly thickened at apices; tarsal segments broad, the third segment over half as long as last segment, claws not widely divergent.

Length, 25 millimeters; breadth, 9.5.

Holytype, a female, in the author's collection, taken at Hinokiyama, northern Formosa, altitude 1,500 meters, July 17, 1934, by Y. Izumi.

Genus CEREOPSIUS Pascoe

CEREOPSIUS PRAETORIUS (Erichson).

Lamia praetoria ERICH., Nova Acta Acad. Nat. Cur. 16 suppl. 1 (1834) 268, pl. 39, fig. 7; NEWMAN, Entomologist 1 (1842) 276 (*Monohammus* ?).

Broad, narrowed posteriorly; head deeply grooved between antennal supports; prothorax broader than long, sharply tuberculate laterally behind middle, constricted basally; antennæ nearly

twice as long as body in male, slightly longer in female, scape long, broadly thickened at apex, third and following segments gradually decreasing in length and thickness, hardly swollen at apices; elytral apices slightly rounded and subtransversely truncated; black, anterior portion of prothorax, and elytra, except base, apex and a broad spot in middle, testaceous-orange; clothed with a pale silvery pubescence beneath.

A specimen in the author's collection, taken at Imororu, Botel-Tobago Island (Kotosho), east of the southern tip of Formosa, latitude 22° 5′ north, June 6, 1934, by Y. Izumi.

GLENEINI

Genus GLENEA Newman

GLENEA LUTEICOLLE Gressitt sp. nov.

Narrow, subparallel; clothed completely beneath with a thin, but dense, dirty silvery white pubescence; top and front of head and prothorax above and at sides clothed with a dense pale orange pubescence; scutellum clothed with dense white pubescence; elytra black, clothed with a thinner, olive-gray pubescence; antennæ black, very thinly clothed with pale pubescence; most of body also sparsely clothed with fine, erect hairs, which are dark on dorsal surface of body and pale beneath, and present on antennæ only on the underside of basal segments and with single, apical ones on remaining segments.

Head fairly vertical in front; surface finely punctate; frons slightly higher than wide, rectangular; clypeus with anterior margin glabrous; labrum very short; vertex very slightly concave between antennal supports. Antennæ slightly longer than body; second and third segments only swollen at apices; scape short, subcylindrical, slightly thinner at base, second segment barely longer than broad; third segment nearly twice length of scape and one and one-half times as long as fourth; fourth to tenth segments subequal, gradually shorter; apical segment noticeably shorter than tenth, subfusiform. Prothorax subcylindrical, slightly swollen in middle, barely broader than long, slightly constricted at base, two-thirds as broad as elytra; regularly and minutely punctured. Scutellum longer than broad, subtrapeziform, rounded posteriorly. Elytra narrow, subparallel; slightly swollen on anterior part of disc; sides sharply deflexed, with three longitudinal costæ which disappear before apex, the middle one commencing after the first quarter, separated by two grooves each with a single line of punctures; dorsal surface punctured

fairly regularly in longitudinal lines, the punctures weaker posteriorly and disappearing before apex; apices narrowed and obliquely truncate, not toothed, the internal angles subobtuse. Ventral surface impunctate. Legs thin; femora very slightly swollen; first segment of fore and middle tarsi, respectively, equal in length to second and third combined, first segment of hind tarsi nearly as long as remainder of tarsi; claws small, reddish brown.

Length, 11.5 millimeters; breadth, 3.

Holotype, No. 50900, United States National Museum, collected by the author at Hassenzan, Formosa, altitude 1,900 meters, June 24, 1934; and one paratype in the author's collection.

A typical *Glenea;* very closely related in structure to *G. chrysomaculata* Schwarzer, of Formosa.

? GLENEA LATA Gressitt sp. nov.

Very broad, shortened, dorsoventrally compressed; elegant, of a rich golden chestnut-brown color; clothed with a thin golden pubescence, and short, erect, golden hair; marked with thick, creamy, yellowish white spots of dense scale hairs in the following manner: Prothorax above at each side with two approximate or connected spots of irregular shape, nearly inclosing a small blank circle between each pair, commencing near apex and extending to basal margin where they are broadest and approach each other closest; elytra with a round spot at middle of basal margin of each which is slightly broader than long; a second oval small spot at side before middle; a third large spot practically touching suture, longer than broad, broader than half of elytron, indented anterolaterally, and centered slightly before middle; a fourth subcircular spot, longer than broad, centered at beginning of last quarter and nearer margin than suture, second in size to the preceding one; and a fifth, small, transverse apical one; head with a narrow stripe behind the eye; two small spots, one before the other and smaller, at side of prothorax near coxal insertion; mesothorax with a moderate subtriangular spot covering most of episternum and part of epimeron; metepisternum with two spots, one before the other; and abdominal segments, except fourth, each with a round spot near lateral margin and nearly hidden by sides of elytra.

Head very short, broad, surface finely and evenly punctate; frons rectangular, broader than high; vertex broad, hardly depressed in middle; occiput swollen; eyes narrow, ventral lobe

subcircular. Antennæ one-third longer than body; distantly inserted; clothed with auburn hairs internally and at apex of each segment; scape cylindrical, narrowed at base; second segment longer than broad, third segment one and one-half times as long as scape and one-fourth again as long as fourth segment, fifth segment two-thirds as long as fourth, subequal to succeeding segments which gradually decrease in length to apex. Prothorax one and one-half times as broad as long; transversely impressed before and behind middle; posterior margin concave at each side of middle, surface evenly punctate. Scutellum as broad as long, rounded posteriorly. Elytra broad, slightly narrowed posteriorly; apices broadly rounded, internal angle nearly a right angle; surface moderately punctate, very finely near apex; sides evenly rounded, without ridges or grooves. Ventral surface slightly punctate before and at sides of thorax, microscopically on abdomen; last abdominal segment nearly as long as second to fourth segments combined. Legs short; tarsi small and narrow, hind pair hardly more than half as long as hind tibiæ, first segment equal to two succeeding segments combined, claws small, strongly divaricate and prominently toothed.

Length, 13.3 millimeters; breadth, 5.

Holotype, female, a unique, in the author's collection, taken by the author at Kuraru, in Koshun, near South Cape, Formosa, latitude 22° north, altitude 160 meters, May 6, 1934.

TETRAOPINI

Genus **CHREONOMA** Pascoe

CHREONOMA ATRITARSIS Pic.

Chreonoma atritarsis Pic, Mat. Longicornes 8 2 (1912) 21.

Subparallel, very slightly broadened posteriorly; testaceous, the elytra deep metallic blue to violaceous, marked with black on antennæ, except for basal portions of first four segments; apices of mandibles, tarsi, and apices of tibiæ also black; clothed on body and on antennæ internally with long erect hairs, which are long basally and short apically on elytra and light-colored on the pale areas and black on the dark areas.

Head broad, shiny, very sparsely punctate, shallowly concave between the antennal supports. Antennæ five-sixths as long as the body; scape broadened and slightly flattened, punctate basally and sharply rugulose apically; second segment twice as long as broad; third segment as long as scape; fourth segment two-thirds as long as third; fifth to tenth slightly diminishing and

eleventh longer, finely attenuated and suggesting two segments. Prothorax short, greatly swollen on disc and at sides in middle, the swollen portion of disc grossly punctate and projecting slightly posteriorly. Scutellum short, broadly rounded posteriorly. Elytra fairly evenly punctate except at apices. Ventral surface minutely punctate at sides; fore coxæ contiguous, intercoxal process of mesosternum narrow, extending posteriorly four-fifths of space between coxæ; second segment of tarsi less than half as long as either first or third segments.

Length, 11 millimeters; breadth, 3.5.

One specimen collected by the author at Hassenzan, Formosa, altitude 1,100 meters, June 20, 1932; another specimen collected by the author at Kusukusu, southern Formosa, altitude 150 meters, April 13, 1932.

This species differs from *C. fortunei* Thomson in the larger size, wider body, more swollen prothorax, violaceous elytra, black tarsi, lighter bristles of the anterior regions, and in the primary antennal segments being part yellow instead of wholly black.

Habitat.—China (?); Formosa (Hassenzan, Kusukusu). Doubtfully recorded from China by Pic in the original description. New to Formosa.

Genus ANASTATHES Gahan

ANASTATHES PARVA Gressitt sp. nov.

Small, parallel-sided; entirely of a shiny, ochraceous-yellow color except for antennæ, eyes, mandibles, and outer edges of tibiæ, which are black; body, legs, and basal three segments of antennæ nitid and shiny; body and legs clothed with suberect golden hairs, densest on frons and pygidium, sparsest on sides of pronotum and more reclining on elytra.

Head broad, swollen in front, nearly flat between antennal insertions; surface fairly evenly punctate; ventral part of eyes nearly round, dorsal part oval, sublongitudinal; last segment of the maxillary palpi nearly twice as long as the preceding segment. Antennæ (male) extending very slightly beyond the elytral apices; clothed with flying brownish black hairs on first three segments, and on inner sides and apices of remaining segments; first three segments subglabrous, densely and finely punctulate, remaining segments subopaque, finely granulose; scape subcylindrical, very slightly thickened towards apex; second segment hardly as long as broad; third segment slightly longer than scape, very slightly swollen at apex; fourth segment two-thirds as long as scape; fifth to tenth segments successively

slightly shorter, cylindrical, and not thickened at apices; apical segment slightly longer than tenth, finely and acutely pointed at apex. Prothorax one-third again as broad as long; middle portion transversely and rather feebly swollen; surface rather irregularly punctate. Scutellum very short and broad, rounded posteriorly; finely punctate. Elytra parallel-sided, rounded apically, shiny; punctured in nine or ten longitudinal rows. Ventral surface punctured slightly at sides only; intercoxal process of prosternum nearly reaching level of coxæ; intercoxal process of mesosternum subvertical in front, its posterior margin with a concavity into which fits the apex of the metasternal process, which extends anteriorly more than halfway between the coxæ. Legs with the tarsi very narrow, the second segment smaller than third, which is slightly smaller than first.

Length, 7.5 to 9 millimeters; breadth, 2.3 to 2.75.

Holotype, male, No. 50901, United States National Museum, taken by the author at Bukai, near Hori, central Formosa, altitude 1,000 meters, June 12, 1934; two paratopotypes taken the same day, and a third paratype taken at Hori, Formosa, altitude 650 meters, June 9, 1934, in the author's collection.

This species agrees fairly well with the essential characters of the genus, hitherto recorded from Siam, Malacca, and Java, particularly in the structure of the intercoxal processes; however, the third antennal segment is not shorter than the scape, and the prothorax is meagerly swollen above and at sides.

JAPANESE NAMES

Noemia incompta sp. nov. Taiwan-hoso-kamikiri-(mushi).
Oplatocera oberthuri Gahan. Naname-suji-kamikiri.
Hemadius oenochrous Fairmaire. Musha-miyama-kamikiri.
Pseudaeolesthes chrysothrix (Bates). Ki-madara-kamikiri.
Chloridolum accensum (Newman). Ō-midori-kamikiri.
Aglaophis decemmaculatus sp. nov. Hori-shiro-heri-kamikiri.
Cleomenida pulchella sp. nov. Ao-kenaga-kamikiri.
Monochamus flocculatus sp. nov. Futo-higenaga-kamikiri.
Cereopsius praetorius (Erichson). Koto-futo-kamikiri.
Glenea luteicolle sp. nov. Hoshi-nashi-kamikiri.
Glenea lata sp. nov. Futo-hoshi-kamikiri.
Chreonoma atritarsis Pic. Taiwan-ruri-kamikiri.
Anastathes parva sp. nov. Bukai-kamikiri.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXVI[1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

THREE PLATES

The majority of the species of crane flies discussed in the present report are from western China, where they were collected by the Rev. Mr. George M. Franck and by the Rev. Mr. David C. Graham. A further considerable series was taken in Formosa and the Loochoo Islands by Mr. J. Linsley Gressitt. Smaller series were taken in eastern China by Mr. E. Suenson and in Formosa by Prof. Teiso Esaki. One further interesting species from Siam was sent to me for study from the American Museum of Natural History, through the friendly interest of Dr. C. Howard Curran. The extensive Graham collections are preserved in the United States National Museum, the other species in my own collection of Tipulidæ. As a result of the present survey, four generic groups are added to the Tipuloidea of China; namely, *Ptychoptera, Paracladura, Phalacrocera,* and *Gymnastes.* For convenience of treatment I have included various records of the tipuloidean families Ptychopteridæ and Trichoceridæ in the present discussion.

PTYCHOPTERIDÆ

PTYCHOPTERA CLITELLARIA sp. nov. Plate 1, fig. 1.

General coloration of thorax yellow, the entire præscutum solidly black, brightened only on the humeral portions; femora yellow, the tips black; wings with a strong brownish yellow tinge, very restrictedly and sparsely patterned with brown; Rs relatively long, about three-fourths the length of R_{4+5}; basal abdominal tergites yellow, black medially, the outer segments uniformly blackened.

[1] Contribution from the entomological laboratory, Massachusetts State College.

Female.—Length, about 11 millimeters; wing, 11.5.

Rostrum yellow; palpi brown, the terminal segment brownish black. Antenna broken beyond the brown scapal segment. Head black, the front more reddish brown.

Pronotum yellow. Mesonotal præscutum yellow, the entire disk covered by a polished black area, restricting the ground to narrow humeral and anterolateral brightenings; scutum, scutellum, and mediotergite light yellow. Pleura entirely light yellow. Halteres dusky. Legs with the coxæ and trochanters yellow; femora yellow, the tips black, including about the distal eighth; tibiæ dark brown, the tips black; tarsi black (a single leg, middle, remains). Wings (Plate 1, fig. 1) with a strong brownish yellow tinge, cells C and Sc, together with the prearcular field, clearer yellow; very tiny to scarcely evident brown spots along cord and at forks of R_{4+5} and M_{1+2}; veins dark brown, brighter in the flavous areas. Macrotrichia of cells distributed about as figured (shown by stippled dots). Venation: Rs relatively long, about three-fourths the length of R_{4+5}; r-m connecting with Rs just before fork; cell M_1 small.

Abdominal tergites one to four yellow laterally, black medially; on outer segments, the entire dorsum black; basal sternites yellow, the outer segments and ovipositor black, only the outer ends of cerci more reddish.

Habitat.—China (Szechwan).

Holotype, female, Yachow, 1930 (*Graham*).

Ptychoptera clitellaria is readily told from all other described species of the genus by the peculiar coloration of the præscutum and abdomen. The family had not been recorded from China.

TRICHOCERIDÆ

TRICHOCERA ARISANENSIS Alexander.

Trichocera arisanensis ALEXANDER, Philip. Journ. Sci. 56 (1935) 339.

Described from the high mountains of Formosa. Mount Omei, Szechwan, altitude 10,800 to 11,000 feet, August 16 to 20, 1934 (*Graham*).

PARACLADURA ELEGANS Brunetti.

Paracladura elegans BRUNETTI, Rec. Indian Mus. 6 (1911) 288.

Described from the eastern Himalayas. Mount Omei, Szechwan, altitude 11,000 feet, August 18, 1934 (*Graham*).

PARACLADURA GRACILIS Brunetti.

Paracladura gracilis BRUNETTI, Rec. Indian Mus. 6 (1911) 287.
Trichocera flava BRUNETTI, Fauna Brit. India, Diptera Nematocera (1912) 512.

Described from the eastern Himalayas. Mount Omei, Szechwan, altitude 11,000 feet, August 18, 1934 (*Graham*).

PARACLADURA OMEIENSIS sp. nov. Plate 1, fig. 2.

General coloration of mesonotum brownish yellow, the præscutum darkened medially; pleura darkened; antennal flagellum black; knobs of halteres dark brown; wings grayish yellow, the veins pale brown; abdominal tergites dark brown.

Female.—Length, about 3.5 to 3.7 millimeters; wing, 3.8 to 4.3.

Rostrum and palpi dark. Antennæ with scape orange-yellow; remainder of antenna black. Head pale brown.

Mesonotum chiefly brownish yellow, the præscutum conspicuously darkened medially; posterior sclerites of mesonotum pale. Pleura rather strongly darkened, paler in one of the paratypes. Halteres dusky, the base of stem yellow, the knob dark brown. Legs with the coxæ and trochanters pale; remainder of legs pale brown, the outer tarsal segments somewhat darker. Wings (Plate 1, fig. 2) uniformly suffused with grayish yellow; stigma lacking; veins pale brown. Venation: M_{3+4} forking at near midlength of cell 1st M_2; m-cu on M_4 some distance beyond base.

Abdominal tergites dark brown, the sternites paler. Ovipositor with the cerci broad-based, the distal third strongly narrowed.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*). Paratopotype, 1 female, 1 broken, altitude 5,500 to 10,800 feet, August 18, 1934 (*Graham*).

Paracladura omeiensis is readily distinguished from *P. gracilis* Brunetti by the much darker coloration of the body and appendages.

TIPULIDÆ

TIPULINÆ

TIPULA (FORMOTIPULA) UNIRUBRA sp. nov. Plate 1, fig. 3; Plate 2, fig. 25.

Mesonotum black, with three grayish stripes, the median one divided by parallel capillary dark vittæ for about the cephalic

half; scutellum and mediotergite heavily pruinose; legs black; wings with a uniform grayish brown suffusion, cell Sc darker than cell C; Rs exceeding m-cu; abdomen black, the segments pruinose, segment two reddish orange; male hypopygium with the tergite notched medially; dististyle complex, with two blackened spines on posterior margin.

Male.—Length, about 13 millimeters; wing, 15.

Female.—Length, about 13 to 14 millimeters; wing, 15 to 16.

Rostrum and palpi black, sparsely pruinose. Antennæ black, the pedicel a trifle paler; verticils longer than the segments. Head black, sparsely pruinose behind.

Mesonotal præscutum black, with three grayish stripes, the median one divided by parallel capillary black vittæ that occupy about the cephalic half of the sclerite, the stripe being entire behind; scutum, scutellum, and mediotergite obscure, heavily pruinose. Pleura black, more pruinose on ventral sternopleurite. Halteres black. Legs with the coxæ and trochanters dull black; remainder of legs black, the extreme base slightly brightened. Wings (Plate 1, fig. 3) with a uniform grayish brown suffusion; cell Sc distinctly darker than cell C; stigma oval, darker brown; veins brownish black. Venation: Rs longer than usual in the subgenus, exceeding m-cu; R_{1+2} with trichia on basal fifth; m-cu elongate, at fork of M_{3+4}.

Abdomen black, the second tergite reddish orange, the corresponding sternite more obscure brownish red; basal tergite vaguely brightened medially; third and succeeding segments black, sparsely pruinose, without brightening; hypopygium and ovipositor black.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*). Allotopotype, female. Paratopotypes, 2 females.

The nearest ally is apparently *Tipula* (*Formotipula*) *rufizona* Edwards (western China), which has the præscutum with four complete blackish gray stripes and with the orange color of the abdomen including parts of the third and fourth tergites. The present fly is very different from *T.* (*F.*) *friedrichi* Alexander and *T.* (*F.*) *holoserica* Matsumura in the notched ninth tergite of the male hypopygium.

NEPHROTOMA BIARMIGERA sp. nov. Plate 1, fig. 4; Plate 2, fig. 26.

General coloration yellow; occipital brand not or scarsely indicated; præscutum with three polished black stripes; scutellum

yellow; mediotergite yellow, the posterior border a little more reddish; pleura yellow, variegated by more reddish areas; halteres pale yellow; femora yellow, the tips not or scarcely darkened; wings with a pale yellow suffusion; abdomen yellow, the tergites trivittate with black, the median stripe broad but interrupted; subterminal segments black; male hypopygium with a heavily blackened, slightly bifid lobe from the ventromesal portion of basistyle.

Male.—Length, 11 to 12 millimeters; wing, 12 to 13.

Female.—Length, about 15 millimeters; wing, 13.5.

Frontal prolongation of head yellow; outer half of dorsal surface, including nasus, darkened; palpi chiefly pale. Antennæ with the scape light yellow; pedicel pale brown; flagellar segments brownish black, relatively elongate and moderately incised; verticils shorter than the segments. Head with the vertical tubercle yellow, darker posteriorly; remainder of head more orange-yellow; occipital brand not or scarcely indicated.

Pronotum and pleura orange-yellow. Mesonotal præscutum light yellow, with three polished black stripes that are very narrowly bordered by more velvety black; lateral stripes weakly outcurved with velvety black; in female, median stripe with cephalic half narrowly divided by more reddish brown; scutum yellow, each lobe chiefly polished black, narrowly bordered by more velvety black; scutellum yellow; mediotergite light yellow, the posterior border with more reddish, paired areas. Pleura yellow, variegated by more reddish areas on anepisternum, ventral sternopleurite, meron, and posterior portions of pleurotergite. Halteres pale yellow, the base of each knob weakly darkened. Legs with the coxæ and trochanters yellow; femora yellow, the tips not or scarcely darkened; tibiæ and basitarsi brownish yellow, the tips of the latter, together with remainder of tarsi, black. Wings (Plate 1, fig. 4) with a pale yellow suffusion; stigma medium brown; a very vague and restricted dark cloud on anterior cord; veins brown, paler in prearcular field. Venation: Sc_2 ending just beyond origin of Rs; cell M_1 very short-petiolate to narrowly sessile; M_4 departing shortly before fork of M_3, m-cu on base of former.

Abdomen yellow, the tergites trivittate with black, the areas interrupted at the bases of the segments; median stripe broad and conspicuous, beginning on the first tergite; segments seven and eight, and the central portion of tergite nine black, the remainder of hypopygium pale. In female the tergal areas more

expanded on posterior portion of segments to form triangles. Male hypopygium with the caudal border of tergite (Plate 2, fig. 26, 9*t*) almost evenly, convexly rounded, without projecting horns or lobes. Outer dististyle, *od*, not markedly attenuate at apex. Inner dististyle, *id*, broad, with two blackened lobes, additional to the slender beak; surface with conspicuous setæ. Basistyle at ventromesal portion produced into a blackened lobe, *b*, the apex slightly bifid, the surface microscopically corrugated. A pale membranous median lobe, directed cephalad, from outer portion of eighth sternite.

Habitat.—China (Chekiang).

Holotype, male, hills south of Ning-po, halfway to Nimrod Sound, May 1, 1925 (*Suenson*). Allotopotype, female. Paratopotype, male.

Nephrotoma biarmigera is most generally similar to species such as *N. citrina* Edwards and *N. nigricauda* Alexander, differing from both in the coloration. The peculiar blackened lobe on the basistyle of the male hypopygium is very different from the condition in any other regional *Nephrotoma* that I have examined.

NEPHROTOMA EVITTATA sp. nov. Plate 1, fig. 5; Plate 2, fig. 27.

Allied to *impigra;* general coloration yellow; frontal prolongation of head yellow, unmarked; palpi pale yellow; flagellar segments (male) strongly incised; occipital brand undifferentiated; mesonotal præscutum with three polished black stripes; mediotergite yellow; wings whitish subhyaline, cell Sc uniformly dark brown; stigma pale brownish yellow; abdomen orange, without a median tergal stripe but with pale brown areas on sides of tergites two to five, inclusive; hypopygium pale; male hypopygium with the eighth sternite very weakly emarginate, with a small rounded cushion in the notch, the setæ surrounding the emargination unusually sparse and not of unusual length.

Male.—Length, about 8.5 millimeters; wing, 9.

Frontal prolongation of head yellow, the dorsal surface and nasus not or scarcely darkened; setæ of nasus black; palpi pale yellow throughout. Antennæ with basal three segments yellow, the remainder of flagellum black; antenna relatively long, if bent backward extending approximately to base of abdomen; flagellar segments rather strongly incised; verticils shorter than

the segments. Head orange, the occipital brand not differentiated; posterior genæ a little paler.

Pronotum yellow throughout. Mesonotal præscutum yellow, with three polished black stripes, each of the lateral pair with a much paler brown spot outside its anterior end; scutum yellow, the lobes extensively blackened, the color involving the outer end of the suture and the adjoining lateral portion of the scutal lobe as a velvety-black U-shaped line; scutellum weakly infumed, the parascutella yellow; mediotergite yellow, the posterior border vaguely more reddish yellow. Pleura light yellow, with very vague, more reddish areas on anepisternum, ventral sternopleurite, ventral meron, and posterior portion of pleurotergite. Halteres pale brown, the apices of knobs light yellow. Legs with the coxæ and trochanters yellow; femora yellow, the extreme tips darkened; tibiæ yellow, the outer ends passing into black; tarsi broken. Wings (Plate 1, fig. 5) whitish subhyaline; cell Sc uniformly dark brown; stigma pale brownish yellow; veins dark brown. Venation: Sc_2 ending just beyond origin of Rs, Sc_1 preserved; cell M_1 very short-petiolate; M_4 departing a short distance before M_3; m-cu on M_4 just beyond its base.

Abdomen entirely orange, without indications of a median dark tergal stripe but with pale brown lateral areas on tergites two to five, inclusive; hypopygium entirely pale. Male hypopygium with the tergite (Plate 2, fig. 27, 9*t*) bearing two slender acute lateral spines, each with about three blackened denticles near base. Outer dististyle, *od*, pale throughout, not greatly attenuated, the setæ relatively sparse and inconspicuous. Inner dististyle, *id*, relatively slender, the apical beak long and narrow. Eighth sternite, 8*s*, with a very small median notch that bears a tiny rounded cushion set with abundant microscopic setulæ; setæ of sternite surrounding this emargination very sparse and of ordinary length.

Habitat.—China (Szechwan).

Holotype, male, Shin-Kai-Si, Mount Omei, altitude 4,400 feet (*Graham*).

The present fly is allied to *Nephrotoma impigra* Alexander (western China), differing notably in the coloration of the body, as the lack of a dark median stripe on the abdominal tergites. The details of the male hypopygium are distinctive.

the segments. Head orange, the occipital brand not differentiated; posterior genæ a little paler.

Pronotum yellow throughout. Mesonotal præscutum yellow, with three polished black stripes, each of the lateral pair with a much paler brown spot outside its anterior end; scutum yellow, the lobes extensively blackened, the color involving the outer end of the suture and the adjoining lateral portion of the scutal lobe as a velvety-black U-shaped line; scutellum weakly infumed, the parascutella yellow; mediotergite yellow, the posterior border vaguely more reddish yellow. Pleura light yellow, with very vague, more reddish areas on anepisternum, ventral sternopleurite, ventral meron, and posterior portion of pleurotergite. Halteres pale brown, the apices of knobs light yellow. Legs with the coxæ and trochanters yellow; femora yellow, the extreme tips darkened; tibiæ yellow, the outer ends passing into black; tarsi broken. Wings (Plate 1, fig. 5) whitish subhyaline; cell Sc uniformly dark brown; stigma pale brownish yellow; veins dark brown. Venation: Sc_2 ending just beyond origin of Rs, Sc_1 preserved; cell M_1 very short-petiolate; M_4 departing a short distance before M_3; m-cu on M_4 just beyond its base.

Abdomen entirely orange, without indications of a median dark tergal stripe but with pale brown lateral areas on tergites two to five, inclusive; hypopygium entirely pale. Male hypopygium with the tergite (Plate 2, fig. 27, 9*t*) bearing two slender acute lateral spines, each with about three blackened denticles near base. Outer dististyle, *od*, pale throughout, not greatly attenuated, the setæ relatively sparse and inconspicuous. Inner dististyle, *id*, relatively slender, the apical beak long and narrow. Eighth sternite, 8*s*, with a very small median notch that bears a tiny rounded cushion set with abundant microscopic setulæ; setæ of sternite surrounding this emargination very sparse and of ordinary length.

Habitat.—China (Szechwan).

Holotype, male, Shin-Kai-Si, Mount Omei, altitude 4,400 feet (*Graham*).

The present fly is allied to *Nephrotoma impigra* Alexander (western China), differing notably in the coloration of the body, as the lack of a dark median stripe on the abdominal tergites. The details of the male hypopygium are distinctive.

NEPHROTOMA DEFINITA sp. nov. Plate 2, fig. 28.

General coloration yellow; antennal scape and pedicel yellow, flagellum black; head orange, the occipital brand small and inconspicuous, reddish brown; mesonotal præscutum yellow, with three piceous-black stripes, the anterior half of the median stripe paling to reddish brown; posterior half of mediotergite darkened; knobs of halteres yellow; femora yellow, the extreme tips dark brown; wings whitish, stigma and cell Sc darkened; abdomen orange, the median region of tergite two and base of sternite eight blackened; hypopygium orange; eighth sternite long and sheathing, the caudal margin unmodified.

Male.—Length, about 12 millimeters; wing, 10.5.

Female.—Length, about 18 millimeters; wing, 13.

Frontal prolongation of head yellow, more reddish above; nasus pale; palpi with the basal two segments slightly darkened, the outer segments yellow. Antennæ with scape and pedicel yellow, the flagellum black; flagellar segments very weakly incised. Head orange, the vertical tubercle more yellowish; occipital brand small and inconspicuous, reddish brown; in female, with a narrow dark vitta to summit of vertical tubercle.

Pronotum yellow medially, darkened laterally. Mesonotal præscutum yellow, with three polished piceous-black stripes, the anterior half of the median stripe paling to reddish brown; lateral stripes straight; scutum yellow, each lobe with two black areas; central portion of suture blackened, sending a short median line caudad onto the scutum to form a Y-shaped figure; a narrow black streak before wing root; scutellum brown, parascutella yellow; mediotergite yellow, with nearly the posterior half occupied by a transverse-oval dark area. Pleura yellow, variegated by dark reddish on propleura, anepisternum, ventral sternopleurite, and meron; dorsal and ventral pleurotergite similarly colored. Halteres dark, the base of stem restrictedly pale, the knob chiefly yellow. Legs with the coxæ and trochanters reddish yellow; femora yellow, the extreme tips narrowly but conspicuously dark brown; tibiæ yellow, the tips narrowly darker; tarsi passing into black. Wings whitish; stigma, cell Sc, and the narrow cell Cu_1 dark brown; veins brown. Stigma with a few trichia. Venation: Sc_1 preserved; Rs short; M_4 arising at the same point as M_3; cell M_1 sessile.

Abdomen orange, the median region of tergite two and base of sternite eight blackened; hypopygium orange, reduced in size. In female the tergal darkened areas a little more extensive.

Male hypopygium with the tergite (Plate 2, fig. 28, 9*t*) produced into two lateral horns that merge into the thickened caudal margin, densely set with spines and stout setæ. Outer dististyle, *od*, relatively small, pale throughout, including the setæ. Inner dististyle, *id*, relatively narrow, the outer border unmodified. Ninth sternite reduced in area. Eighth sternite long and sheathing, the caudal margin unmodified.

Habitat.—Formosa.

Holotype, male, Sumaän, altitude 2,500 feet, August 21, 1921 (*Esaki*). Allotopotype, female, returned to Professor Esaki.

The coloration of the præscutum is somewhat as in the much smaller and otherwise very distinct *Nephrotoma parva* (Edwards).

NEPHROTOMA CAUDIFERA sp. nov. Plate 1, fig. 6; Plate 2, figs. 29, 30.

General coloration yellow; mesonotal præscutum with three polished black stripes, each of the lateral pair with a velvety-black spot at its anterior end; head orange throughout, with no occipital brand; halteres dusky throughout; wings with a brownish tinge, the stigma not or scarcely darker; about a dozen stigmal trichia in cell R_1; abdomen orange-yellow, the seventh and eighth tergites weakly darkened; inner dististyle of hypopygium with a long, pale, tail-like extension behind; ninth sternite with a large, median, cushionlike lobe.

Male.—Length, about 10 millimeters; wing, 10.5.

Frontal prolongation of head yellow, the dorsum, including nasus, darkened; palpi dark brown. Antennæ of moderate length, if bent backward extending to shortly beyond wing root; scape orange-yellow; pedicel reddish brown; flagellum black; flagellar segments moderately incised; verticils shorter than the segments. Head orange throughout; no occipital brand.

Pronotum entirely yellow. Mesonotal præscutum yellow, with three polished black stripes, each of the lateral pair with a velvety-black outward extension opposite its anterior end; scutum yellow, the lobes chiefly polished black, the outer ends of suture restrictedly velvety black; scutellum brown, parascutella yellow; mediotergite yellow, without evident darkenings. Pleura yellow, the ventral sternopleurite a little more reddish. Halteres dusky throughout. Legs with the coxæ and trochanters yellow; femora obscure yellow; tibiæ dark brown; tarsi black. Wings (Plate 1, fig. 6) with a brown tinge, the stigma not or scarcely darker, with about a dozen trichia in cell R_1; prearcular region a trifle more yellowish; veins dark brown. Vena-

tion: Sc_2 ending opposite origin of Rs, Sc_1 represented by a slight spur; cell M_1 narrowly sessile; M_4 a short distance before fork of M_3, with m-cu shortly beyond base of M_4; cell 2d A relatively narrow.

Abdomen orange-yellow, very indistinctly marked with darker, only the seventh and eighth tergites weakly infumed. Male hypopygium with the ninth tergite (Plate 2, fig. 29, 9*t*) having the lateral spines, as viewed from above, slender, with two teeth near base; intermediate lobes with abundant spines. Outer dististyle (Plate 2, fig. 30, *od*) relatively broad across basal half, the apex slightly attenuated. Inner dististyle, *id*, very high, with a long, pale, caudal extension. Ninth sternite with a large, protuberant, median cushion. Eighth sternite with the posterior margin transverse, unmodified.

Habitat.—Formosa.

Holotype, male, Hassensan, altitude 5,500 feet, July 7, 1934 (*Gressitt*).

Nephrotoma caudifera is somewhat similar to species such as *N. flammeola* Alexander and *N. subpallida* Alexander, of Japan, but is very distinct in the details of coloration and structure of the male hypopygium, notably the inner dististyle.

NEPHROTOMA NIGROSTYLATA sp. nov. Plate 1, fig. 7; Plate 2, fig. 31.

General coloration yellow; præscutum with three polished black stripes, each of the lateral pair with a velvety-black spot opposite its anterior end; antennæ (male) relatively long; occiput and vertex with a linear black vitta almost to summit of vertical tubercle; mediotergite yellow, the posterior border darkened; abdomen yellow, the tergites with three black stripes, the sternites with a median, interrupted black stripe; hypopygium black, including the styli; margin of outer dististyle provided with weak denticles; eighth sternite with a tonguelike, median, yellow lobe.

Male.—Length, 10 millimeters; wing, 9.5; antenna, about 4.

Female.—Length, 11 to 12 millimeters; wing, 11 to 11.5.

Frontal prolongation of head polished yellow, the dorsal surface more darkened, the color involving the nasus; palpi black. Antennæ (male) relatively elongate, if bent backward extending to shortly beyond the base of abdomen; basal three segments yellow, the flagellum very weakly bicolorous; basal enlargements of the segments black, the remainder dark brown; flagellar seg-

ments not or scarcely incised; verticils shorter than the segments. Head orange, the occipital brand appearing as a narrow brownish black line that extends cephalad almost to summit of vertical tubercle.

Pronotum obscure yellow, narrowly blackened laterally. Mesonotal præscutum yellow, with three polished black stripes that are not bordered; a velvety-black spot opposite the anterior end of the lateral stripes; scutal lobes very extensively blackened, attaining the suture, the lateral ends of the latter more velvety black; scutellum brownish black medially, the parascutella somewhat paler; mediotergite yellow, the posterior border darkened. Pleura yellowish white, more reddish on the ventral anepisternum, ventral sternopleurite, meron, and posterior portion of pleurotergite. Halteres dusky, the tips of the knobs obscure yellow. Legs with the coxæ and trochanters yellow, the posterior coxæ a little darkened basally; femora and tibiæ yellow, the tips very narrowly darkened; tarsi brown basally, passing into black. Wings (Plate 1, fig. 7) with a faint yellow tinge; prearcular region and cells C and Sc clearer yellow; stigma oval, brown; wing tip vaguely but rather evidently darkened; a very narrow seam on anterior cord; veins brown, more flavous in the yellow regions. Venation: Sc_2 extending a short distance beyond origin of Rs, Sc_1 weakly preserved; Rs shorter than R_{2+3}; cell M_1 with a short to longer petiole; m-cu shortly before M_4, the latter a corresponding distance before the point of departure of M_3.

Abdomen yellow, the tergites narrowly but conspicuously trivittate with black, the median stripe broader, especially behind, the dark color narrowly interrupted at the bases of the segments; sternites yellow, with a narrow, interrupted, black, median stripe; eighth and ninth segments entirely blackened, including the styli but not the appendage of the eighth sternite. Male hypopygium with the caudal margin of the ninth tergite (Plate 2, fig. 31, 9*t*) produced into lateral flattened black lobes, their mesal edges coarsely toothed. Outer dististyle, *od*, slender, blackened, slightly narrowed outwardly, the tip curved and subacute, the margin of style with three or four weak denticles. Inner dististyle, *id*, of peculiar shape, as figured, black throughout; posterior margin with abundant, long, pale setæ. Eighth sternite with a median, yellow, elongate-triangular, tonguelike lobe, its surface microscopically pubescent.

Habitat.—China (Szechwan).

Holotype, male, Chungking, altitude 1,000 to 2,000 feet, May 6 to 27, 1930 (*Graham*). Allotopotype, female. Paratopotypes. 12 of both sexes.

Nephrotoma nigrostylata is very different from all other described regional species. The tonguelike lobe on the eighth sternite is somewhat like that in *N. ligulata* Alexander and *N. parvirostra* Alexander, but in all other regards the present fly is very distinct.

CYLINDROTOMINÆ

PHALACROCERA MINUTICORNIS sp. nov. Plate 1, fig. 8.

General coloration yellow, the vertex black; antennæ of both sexes unusually small, with long conspicuous verticils; mesonotal præscutum with four polished black stripes, the intermediate pair almost confluent; halteres elongate, brownish black; wings long and narrow, with a strong, almost uniform, brown tinge; R_{1+2} entirely atrophied; m-cu beyond fork of M; cell 2d A unusually narrow.

Male.—Length, about 10 millimeters; wing, 9.8.

Female.—Length, about 10 millimeters; wing, 10.

Rostrum very small, brown; palpi black. Antennæ very small and subequal in both sexes, if bent backward ending some distance before wing root; scape yellow, pedicel and flagellum dark brown; flagellar segments subcylindrical to cylindrical, with long conspicuous verticils that are much longer than the segments. Head yellow on front and occiput, the vertex polished black, the posterior orbits narrowly pale.

Pronotum yellow. Mesonotal præscutum yellow, with four polished black stripes, the intermediate pair closely approximated, being separated only by a very vague capillary vitta; scutum pale, the lobes with black centers, the median pale area very broad; scutellum and mediotergite obscure yellow. Pleura yellow. Halteres elongate, brownish black, the base of stem narrowly yellow. Legs with the coxæ and trochanters yellow; femora obscure yellow, brighter at base, the tip passing into brownish black; tibiæ and tarsi black. Wings (Plate 1, fig. 8) long and narrow, with a strong and almost uniform brown tinge, the long-oval stigma slightly darker brown; veins dark brown. Venation: Sc_1 lacking; free tip of Sc_2 present but faint; R_{1+2} entirely atrophied; m-cu variable in position, from more than one-half to nearly its own length beyond fork of M; cell 2d A unusually narrow, with a distinct fold behind the vein.

Abdomen with the basal segments obscure brownish yellow, the outer segments and hypopygium black.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*). Allotopotype, female.

Phalacrocera minuticornis is allied to the Japanese and Formosan species, *P. formosæ* Alexander, *P. megacauda* Alexander, and *P. mikado* Alexander, differing in the narrow, strongly suffused wings, with very narrow cell 2d A, and in the unusually small antennæ in both sexes.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) PRUDENTIA sp. nov. Plate 1, fig. 9; Plate 3, fig. 32.

General coloration of mesonotal præscutum reddish brown, with three brownish black stripes; antennal flagellum black; femora black, with a conspicuous yellow subapical ring; wings light yellow, heavily patterned with brown, including longitudinal seams and streaks; a darker brown area at fork of Sc; Sc long, Sc_2 at tip of Sc_1; R_{1+2} subequal to $Sc_2 + R_1$; m-cu about one-half its length before fork of M; male hypopygium with the ninth tergite deeply emarginate; dististyle small, the basal half globular.

Male.—Length, about 9 millimeters; wing, 11.

Rostrum and palpi black, the former moderately long, exceeding one-half the length of head. Antennæ black, the pedicel a little paler, more yellowish brown; flagellum moderately elongate; segments with weak basal enlargements; longest verticils a little exceeding the segments. Head black; anterior vertex narrow.

Pronotum brownish black. Mesonotal præscutum reddish brown, with three brownish black stripes, the median stripe paling into the ground color on anterior portion; humeral and outer marginal portions of præscutum narrowly blackened; scutal lobes blackened, the median area pale; scutellum and mediotergite chiefly blackened, the latter paler on sides. Pleura chiefly blackened on dorsal portions, including the dorsopleural membrane, the ventral sternopleurite paler. Halteres with base of stem and apex of knob more yellowish. Legs with the fore and middle coxæ brownish black, the posterior coxæ paler; trochanters obscure yellow; femora yellow basally, soon passing into black, with a broad, light yellow, subterminal ring that is some-

what wider than the black apex; tibiæ brownish yellow, the tips narrowly blackened; tarsi black, the proximal ends of basitarsi restrictedly pale; legs relatively long and slender; claws (male) with three or four teeth on basal half. Wings (Plate 1, fig. 9) light yellow, heavily patterned with brown, including seams to the veins and longitudinal streaks in the centers of the cells, the dark color somewhat more extensive than the ground; a small, darker brown spot at fork of Sc; stigma not darker than the remaining pattern of the wings; the pale ground color includes an oblique crossband beyond cord, extending from costa into cell M_4, interrupted only by very narrow seams to the longitudinal veins; cell 2d A darkened except at outer end; veins yellowish brown. Venation: Sc long, Sc_1 ending shortly before fork of Rs, Sc_2 at its tip; Rs long; R_{1+2} subequal to $Sc_2 + R_1$ and R_{2+3}; m-cu about one-half its length before fork of M.

Abdomen brownish black, the styli of the hypopygium more yellow. Male hypopygium (Plate 3, fig. 32) with the tergite, *9t*, broad basally, strongly narrowed outwardly, the caudal margin with a deep rounded emargination, the lateral lobes formed very narrow. A single dististyle, *d*, this relatively small and globular on basal half, the outer portion or beak stout, with numerous small setæ but without spines. Ædeagus, *a*, broad.

Habitat.—China (Szechwan).

Holotype, a broken male, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*).

The nearest allies of the present fly seem to be *Limonia* (*Limonia*) *kashmirica* Edwards and *L.* (*L.*) *synempora* Alexander, which differ conspicuously in the body coloration, venation, especially of the medial field, and in the details of the hypopygium.

LIMONIA (DICRANOMYIA) VETERNOSA sp. nov. Plate 1, fig. 10; Plate 3, fig. 33.

General coloration of thorax yellow, with a dark brown median stripe on pronotum and præscutum; antennæ black throughout; halteres dark brown; wings whitish subhyaline; stigma relatively small, ill-delimited, dark brown; Sc_1 long; abdominal tergites and hypopygium brownish black, the basal sternites yellow; male hypopygium with the basistyle and ventral dististyle complicated by outgrowths.

Male.—Length, 6.5 to 7 millimeters; wing, 7 to 7.5.

Female.—Length, 8 to 9 millimeters; wing, 8 to 8.5.

Rostrum dark brown; palpi black. Antennæ black throughout; flagellar segments long-oval. Head yellowish gray.

Pronotum dark brown above, the sides yellow pollinose. Mesonotal præscutum yellow pollinose, with a conspicuous, dark brown, median stripe extending from the pronotum, as described, becoming obsolete before the suture; scutum and scutellum pale, the mediotergite more darkened. Pleura and pleurotergite yellow pollinose. Halteres dark brown, the base of stem yellow. Legs with the coxæ and trochanters yellow; femora yellow basally, the remainder brown with the tips rather narrowly black, the fore femora more uniformly blackened; tibiæ and tarsi blackened, in cases the former somewhat paler in central portions. Wings (Plate 1, fig. 10) whitish subhyaline; stigma relatively small and ill-delimited, dark brown; veins dark brown. Venation: Sc_1 ending opposite origin of Rs, Sc_2 some distance from its tip, Sc_1 alone subequal to or only a little shorter than Rs; cell 1st M_2 closed; m-cu just before the fork of M, more rarely at the fork.

Abdomen relatively long; tergites, including hypopygium, brownish black; basal sternites yellow, the outer segments black. Male hypopygium (Plate 3, fig. 33) with the tergite, *9t*, transverse, the caudal margin gently emarginate. Basistyle, *b*, with the usual ventromesal lobe complex, produced into a large flattened structure, at its base with a smaller lobe that is tipped with several fasciculate setæ. Dorsal dististyle a slender, relatively straight rod; in most specimens longer and more slender than in the paratype figured. Ventral dististyle, *vd*, of moderate size, the rostral prolongation very stout at base; on outer margin before the spines with a small tubercle that is tipped with three or four strong spines, directed outward; rostral spines long and slender, very slightly unequal in length, arising from a low common tubercle; cephalic portion of style near base of prolongation with a group of long setæ. Gonapophyses, *g*, with mesal-apical lobe slender.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*). Allotopotype, female. Paratopotypes, several males and females with the types; others at 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*).

Limonia (*Dicranomyia*) *veternosa* is very distinct from the other described regional species of the subgenus having complex outgrowths of the basistyle and ventral dististyle of the male hypopygium. The group of setæ on the ventral dististyle

near base is suggestive of the otherwise very different *L.* (*D.*) *basiseta* (Alexander), of Japan.

LIMONIA (RHIPIDIA) MONOCTENIA sp. nov. Plate 1, fig. 11; Plate 3, fig. 34.

Belongs to the *uniseriata* group; mesonotal præscutum with three more or less confluent brown stripes, the interspaces golden pollinose; pleura with a black longitudinal stripe; antennæ (male) with eight unipectinate flagellar segments; halteres yellow; femora with the tips black, on the forelegs very broad; wings dark brown, with four very extensive darker brown costal blotches, the remainder of wing disk with small scattered white areas; Sc_1 ending at near one-third the length of Rs, Sc_2 at its tip; a supernumerary crossvein in cell Sc; m-cu before fork of M; abdominal tergites brownish black; male hypopygium with the rostral prolongation bearing either two or three flattened spines, placed close together at near midlength of the prolongation.

Male.—Length, about 5.5 millimeters; wing, 6.6.

Rostrum and palpi black. Antennæ black, the apical pedicels of the flagellar segments pale; flagellar segments conspicuously unipectinate; longest branches a little shorter than the segments that bear them; basal flagellar segment stout but not distinctly pectinate; flagellar segments two to nine, inclusive, with distinct branches; segments ten and eleven enlarged but not pectinate; terminal segment elongate, exceeding the penultimate. Head brownish gray, the front brighter; anterior vertex narrow, less than the diameter of scape.

Pronotum dark brown. Mesonotal præscutum with three more or less confluent brown stripes, the posterior interspaces and lateral margins golden pollinose, the lateral stripes confluent with the median stripe at anterior ends; posterior sclerites of notum dark brown, the scutellum more pruinose. Pleura brown ventrally, with a conspicuous black longitudinal stripe extending from the cervical region to the base of abdomen, passing beneath the wing root. Halteres pale yellow. Legs with the coxæ brown, the fore coxæ more darkened basally; trochanters light brown; femora yellow basally, the tips black, more extensive on the forelegs where only the bases are narrowly brightened, much narrower on posterior legs, involving only the distal fourth or fifth; tibiæ black; tarsi black, including the posterior pair, much shorter than the tibiæ; claws toothed. Wings (Plate 1, fig. 11) with the ground color rather dark brown, including four even darker costal areas, these much more extensive than the

interspaces; third dark blotch at origin of Rs; remainder of wing membrane variegated by scattered small whitish areas; veins brownish black, the trichia conspicuous. Venation: Sc_1 ending about opposite one-third the length of Rs, Sc_2 at its tip; a supernumerary crossvein in cell Sc at near two-thirds the length of the cell; free tips of Sc_2 and R_2 both pale, in transverse alignment; m-cu shortly before fork of M; anal veins at origin nearly parallel.

Abdominal tergites brownish black, the basal sternites brighter; ventral lobes of dististyles pale. Male hypopygium (Plate 3, fig. 34) with the caudal border of tergite, 9*t*, rather deeply emarginate. Ventral dististyle, *vd*, fleshy, the rostral prolongation relatively long, flattened, bearing two or three spines at near midlength (in the unique type there are three spines on the left style, two on the right); spines sessile, strongly flattened, gently curved, subequal to or shorter than the apex of the prolongation beyond the outermost. Dorsal dististyle suddenly narrowed at apex into a straight spine. Gonapophyses, *g*, with the mesal-apical lobe a straight black point.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 10,800 feet, August 18, 1934 (*Graham*).

Limonia (*Rhipidia*) *monoctenia* is very different from all other regional species of the subgenus in the unipectinate antennæ and pattern of the wings. The only regional member of the group heretofore made known is *L.* (*R.*) *siberica* (Alexander), which has the wing entirely different both in pattern and venation.

ANTOCHA (ANTOCHA) LACTEIBASIS sp. nov. Plate 1, fig. 12; Plate 3, fig. 35.

General coloration of præscutum brownish ocherous, with a median brown stripe; antennæ black throughout; knobs of halteres darkened; legs brown, the terminal tarsal segments passing into black; wings tinged with gray, the prearcular region clear creamy yellow; veins dark brown, very distinct; R_2 and r-m in transverse alignment, both lying far distad, r-m being about one-half the basal section of vein R_{4+5}, cell 1st M_2 about as long as vein M_{1+2} beyond it; m-cu before fork of M; male hypopygium with both dististyles long and slender; outer gonapophyses short, obtuse at tips.

Male.—Length, about 5.5 millimeters; wing, 6.5.

Female.—Length, about 6 millimeters; wing, 6.5.

Rostrum brownish yellow; palpi black. Antennæ black throughout; flagellar segments oval. Head uniformly gray.

Mesonotal præscutum brownish ocherous, with a median brown stripe that is very diffuse, the humeral region brightest; posterior sclerites of mesonotum chiefly dark brown, pruinose. Pleura brownish ocherous, more darkened on the sternopleurite and pleurotergite. Halteres dusky, the knobs darkened. Legs with the forecoxæ darkened, the remaining coxæ and all trochanters pale; remainder of legs brown, the terminal tarsal segments passing into black. Wings (Plate 1, fig. 12) tinged with gray, the prearcular region clear creamy yellow; stigma elongate-oval, darker brown than the ground; veins dark brown, very distinct. Venation: R_2 and r-m in transverse alignment; inner end of cell 1st M_2 somewhat arcuated; basal section of M_3 longer than m; m-cu about one-third its length before the fork of M.

Abdomen dark brown, the hypopygium very little brighter. Male hypopygium (Plate 3, fig. 35) with the tergite, 9*t*, narrowly transverse, the caudal margin straight or very slightly produced at near midlength; dorsal surface of sclerite with a transverse discal grouping of setæ. Outer dististyle elongate, slender, gradually narrowed to the acute tip. Inner dististyle subequal in length and nearly as slender, narrowed to the obtuse tip, the surface with abundant setæ. Gonapophyses with the inner pair slender, subtending the ædeagus, each with a second more slender spine nearer base. Outer gonapophyses much shorter, at apex a little dilated into an obtusely rounded, flattened head.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*). Allotopotype, female. Paratopotypes, 1 male, 1 female, altitude 10,800 to 11,000 feet, August 18, 1934 (*Graham*).

The only regional species that is at all similar to the present fly is *Antocha* (*Antocha*) *setigera* Alexander, which has the male hypopygium entirely different in structure.

HEXATOMINI

HEXATOMA (ERIOCERA) ISHIGAKIENSIS sp. nov. Plate 1, fig. 13.

Belongs to the *mesopyrrha* group; head black; mesonotum dull brown, the præscutum with four more reddish brown stripes; legs yellow, the tips of femora, tibiæ, and basal two tarsal segments narrowly blackened; remaining tarsal segments black; wings on costal third intense orange-yellow, the remaining cells weakly infumed, the veins narrowly bordered by yellow; vein Sc_1 angulated and spurred at tip; cell M_1 present; abdomen black, the shield of ovipositor fiery orange.

Female.—Length, about 20 millimeters; wing, 14.5.

Rostrum and palpi black. Antennæ with the scape black; pedicel dark brown; flagellum yellow, the outer segments somewhat darker. Head brownish black.

Mesonotal præscutum dark chocolate-brown, with four more reddish brown, dull stripes, the intermediate pair separated by a capillary pale line and further delimited on their mesal edges by a narrow brown line; scutum reddish; scutellum at base reddish brown, the outer portion more brownish black and pruinose; mediotergite dark brown, with a pale area at each outer posterior corner. Pleura dark reddish brown, including the dorsopleural membrane. Halteres blackened, the base of stem restrictedly pale. Legs with the coxæ and trochanters reddish brown; femora and tibiæ yellow, the tips narrowly but conspicuously blackened; basal two segments of tarsi yellow, the tips narrowly blackened; outer tarsal segments uniformly black. Wings (Plate 1, fig. 13) intense orange-yellow on about the costal third; centers of cells on remainder of wing weakly darkened but veins narrowly bordered by yellow; anal cells and weak streaks in centers of several other cells slightly paler; veins yellow. Macrotrichia of radial veins abundant, of medial veins lacking or virtually so; costa with abundant setæ (female). Venation: Tip of Sc_1 angularly bent into costa, with a spur at the angulation; R_{1+2} about one-half longer than R_{2+3}; cell M_1 present; m-cu before midlength of cell 1st M_2.

Abdomen black, the surface polished, the posterior margins of the segments more opaque velvety. Shield of ovipositor and preceding segment fiery orange; cerci elongate, brownish black on basal half, the outer portion horn yellow.

Habitat.—Japan (Loochoo Islands).

Holotype, female, Ishigaki Island, August 27, 1934 (*Gressitt*).

The present fly is most nearly allied to species such as *Hexatoma* (*Eriocera*) *cæsarea* (Alexander) and *H.* (*E.*) *kelloggi* (Alexander), differing especially in the coloration of the legs and wings. It is now becoming apparent that the males in the species of the so-called *mesopyrrha* group have the costa with very few setæ, whereas in the associated females these are much more numerous and evenly distributed.

HEXATOMA (ERIOCERA) IRIOMOTENSIS sp. nov. Plate 1, fig. 14.

General coloration black, the præscutum with three more-polished black stripes; halteres black; legs yellow, the tips of the

femora and tibiæ narrowly blackened; wings orange-yellow, variegated by dark brown, chiefly as conspicuous seams to the veins, the pattern much as in *sauteriana;* abdomen black, the tergites polished, with velvety-black margins; hypopygium black; shield of ovipositor reddish.

Male. Length, 11 to 12 millimeters; wing, 8.5 to 10.

Female.—Length, about 21 millimeters; wing, 14.

Rostrum and palpi black. Antennæ with scape and pedicel black; flagellum pale brown; antennæ of male 8-segmented, the flagellar segments gradually decreasing in length to the end. Head velvety black, the vertex and vertical tubercle a little more plumbeous.

Mesonotal præscutum velvety black with three more-polished black to somewhat plumbeous stripes; scutum black, the centers of the lobes more polished; posterior sclerites of notum black. Pleura, including the dorsopleural region, black. Halteres black, the stem a very little paler. Legs with the coxæ and trochanters black; femora yellow, the tips very narrowly black, the amount subequal on all legs; tibiæ yellow, the tips narrowly darkened; basitarsus obscure yellow at proximal end, passing into brown; outer tarsal segments black. Wings (Plate 1, fig. 14) with the ground color deep orange-yellow, conspicuously patterned with dark brown; the dark color appears as relatively narrow seams to the veins beyond the cord, basad of cord forming an oblique cross area in cells R_1, R and M connected with seams along the veins and cord to inclose a large area of the ground in outer ends of cells R and M; cells C and Sc of the ground color; cells Cu and the anals almost uniformly darker, the former invaded near outer end; entire wing apex narrowly margined with dark; veins dark, paler in the flavous portions. Macrotrichia of veins abundant, especially beyond cord. Venation: Sc_2 some distance before tip of Sc_1, just beyond fork of Rs; R_{1+2} about one-half longer than R_{2+3}; m-cu at near midlength of cell 1st M_2; cell M_1 lacking. In the paratype, the right wing shows a curious venational malformation, the basal section of M_{1+2} being misplaced and lying distad of the level of m-cu, thus greatly restricting the area of cell 1st M_2.

Abdomen of male black, with alternate polished and velvety rings; all but distal fourth of each segment polished, more or less nacreous, the apex velvety black; on the outer sternites, the velvety coloration becomes more extensive, involving one-half or more of the segments; hypopygium black. In the female, the

abdomen is more extensively polished black, the genital shield and valves reddish horn-colored.

Habitat.—Japan (Loochoo Islands).

Holotype, male, Iriomote Island, August 20, 1934 (*Gressitt*). Allotopotype, female, August 25, 1934. Paratopotype, male, August 23, 1934.

This beautiful fly is most nearly allied to the Formosan *Hexatoma* (*Eriocera*) *sauteriana* (Enderlein), which differs conspicuously in the black legs, darkened costal border of wings, and black shield of the ovipositor.

ERIOPTERINI

NEOLIMNOPHILA PERREDUCTA sp. nov. Plate 1, fig. 15.

Mesonotal præscutum gray, with four brown stripes, the intermediate pair darker than the lateral ones; trochanters brownish yellow; wings white, heavily patterned with dark brown; R_2 far before fork of R_{3+4}, the latter vein subequal to vein R_3; cell M_1 small; m-cu close to proximal end of cell 1st M_2.

Female.—Length, 7 to 7.5 millimeters; wing, 7.5 to 8.

Rostrum and palpi black. Antennæ black throughout; fusion segment involving four segments. Head brownish gray.

Mesonotal præscutum gray, with four brown stripes, the intermediate pair more intense, separated by a line of the ground color that is about one-half as wide as either stripe; lateral stripes paler; posterior sclerites of mesonotum gray, the centers of the scutal lobes a little darker. Pleura gray. Halteres pale yellow throughout. Legs with the coxæ dark, pruinose; trochanters brownish yellow; remainder of legs black, the femora brightened at extreme base. Wings (Plate 1, fig. 15) white, the prearcular field more cream-colored; cells C and Sc pale brownish yellow; a heavy brown pattern, including the origin of Rs, anterior cord and stigmal area, together with conspicuous seams on certain of the longitudinal veins, including R_5, M_3, Cu_1, and 2d A; veins pale, darker in the infuscated areas. Venation: cell R_2 very small, with R_2 far before fork of R_{3+4}, the latter vein subequal to R_3 alone; r-m more than one-half its length before fork of Rs; cell M_1 small; cell 1st M_2 elongate, with m-cu close to its proximal end.

Abdomen brownish black.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 11,000 feet, August 18, 1934 (*Graham*). Paratopotype, female, altitude 10,800 feet, August 18, 1934.

The nearest ally of the present fly is *Neolimnophila picturata* Alexander, which differs especially in the coloration of the thorax, much heavier wing pattern, and details of venation. Both species have r-m connecting with Rs some distance before the fork of the latter.

GYMNASTES (GYMNASTES) OMEICOLA sp. nov. Plate 1, fig. 16.

Allied to *cyanea;* thorax black, the mesonotum with faint bluish reflections; abdomen uniformly black; fore femora brown, the tips narrowly yellow; middle and hind femora yellow, with two black and two yellow rings at and before apex, the actual tip yellow; wings whitish subhyaline, with three brown crossbands, the basal one not conspicuously narrowed behind, darkening the distal third to half of cell 2d A.

Male.—Length, about 4 millimeters; wing, 4.2.

Female.—Length, about 5 millimeters; wing, 4.8 to 5.

Rostrum and palpi black. Antennæ black throughout. Head polished black; anterior vertex very wide.

Prothorax and mesothorax polished black, variegated by the sulphur-yellow dorsopleural membrane; in the female the mesonotum with bluish reflections, not or scarcely apparent in male. Halteres black, the outer ends of knobs conspicuously pale sulphur yellow. Legs with the coxæ and trochanters black; middle and hind femora yellow basally, the enlarged outer ends with two black subterminal rings, the tip and a subterminal ring yellow, the widest of these annuli being the outer dark one; fore femora more uniformly dark brown, the tip narrowly pale; tibiæ light yellow, the tips conspicuously blackened; basitarsi yellow, the tips black; remaining tarsal segments black. Wings (Plate 1, fig. 16) whitish subhyaline, with three brown crossbands, the more basal band broadest, in the type male not or scarcely reaching vein R in front, in the female broader and distinctly reaching costal border, behind involving the distal third or more of cell 2d A; outer dark bands almost exactly as in *cyanea*, the outer pale band a little wider; veins brown. Venation: Almost exactly as in *cyanea*.

Abdomen black, without blue reflections; ovipositor with horn-yellow cerci.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 7,000 feet, July 17, 1931 (*Franck*). Allotopotype, female. Paratopotype, 1 female, altitude 9,000 feet, July 20, 1931 (*Franck*).

The nearest ally of the present fly is undoubtedly the genotype, *Gymnastes* (*Gymnastes*) *cyanea* Edwards (*violacea* Brunetti), of Ceylon and southern India. The present fly is well-distinguished by the almost total lack of blue or violaceous body reflections; the union of the two dark basal fasciæ of *cyanea* into a single broad band that involves the entire outer end of cell 2d A; and the more conspicuous pale yellow tips of the femora.

GYMNASTES (PARAGYMNASTES) MCKEANI sp. nov. Plate 1, fig. 17.

General coloration black; head, antennæ, and legs entirely black; halteres black, with the tips conspicuously white; wings whitish subhyaline, with three broad brown crossbands, the inner edge of apical band ending at vein M_4; R_2 at or close to fork of R_{3+4}.

Male.—Length, about 5.5 to 6 millimeters; wing, 5.5 to 6.

Rostrum and palpi black. Antennæ black throughout; flagellar segments long-oval, with elongate verticils. Head uniform dull black, gray pruinose.

Thorax entirely black, the surface of præscutum slightly nitidous. Halteres black, the outer half of knob white. Legs black throughout. Wings (Plate 1, fig. 17) whitish subhyaline, with three, broad, complete, dark brown crossbands, the first at level of origin of Rs and tip of vein 2d A, narrower than in *nigripes*, being subequal to or only a trifle wider than the white band beyond it; outer dark bands wide but not as extensive as in *nigripes*, the inner edge of the apical band reaching the posterior margin at vein M_4 instead of vein Cu_1 as is the case in *nigripes;* pale band between the central and outer dark areas relatively broad; a small brown postarcular spot; veins brown, a little paler in the areas. Venation: Cell R_3 unusually large; vein R_4 very long, considerably exceeding Rs; R_2 somewhat variable in position, from at, to a short distance before, fork of R_{3+4} (as figured); m-cu before midlength of cell 1st M_2.

Abdomen black throughout.

Habitat.—Siam (north).

Holotype, male, near Chieng-mai 1928 (*McKean*). Paratopotype, male. Type in the American Museum of Natural History.

Gymnastes (*Paragymnastes*) *mckeani* is named in honor of the collector, Dr. J. W. McKean. The species is closest to *G.* (*P.*) *nigripes* Edwards (Selangor, Perak), differing especially

in the uniform black color of the head and antennæ, and in the distribution of the wing bands.

TEUCHOLABIS (TEUCHOLABIS) IRIOMOTENSIS sp. nov. Plate 1, fig. 18.

Mesonotal præscutum with three confluent polished black stripes; legs black, the bases of fore and middle femora narrowly yellow, the posterior femora entirely black; halteres black throughout; wings subhyaline, the stigma dark brown; veins brownish black; abdominal tergites uniformly black.

Male.—Length, about 6 millimeters; wing, 5.3.

Female.—Length, about 5.5 millimeters; wing, 5.

Rostrum relatively elongate, only a little shorter than the remainder of head, black throughout; palpi black. Antennæ black throughout; flagellar segments short-oval to oval, the verticils longer than the segments. Head black, sparsely pruinose, more heavily so on anterior vertex.

Pronotum darkened above, paling to obscure yellow on sides. Mesonotal præscutum with the humeral region broadly yellow, the remainder of surface chiefly occupied by three confluent black stripes; scutum yellow, the lobes black, the central and lateral portions of the suture remaining pale; scutellum yellow, the parascutella darker; postnotum, including pleurotergite, black. Pleura light yellow, the dorsal anepisternum and ventral sternopleurite a little darkened. Halteres black throughout. Legs with the coxæ and trochanters yellow; femora black, the bases of the fore and middle pair narrowly yellow, including the proximal fourth or thereabouts; posterior femora entirely black; tibiæ and tarsi black. Wings (Plate 1, fig. 18) subhyaline, with a faint brownish tinge, most evident in the outer radial field; stigma subcircular, dark brown; cell Sc weakly infumed; veins brownish black. Costal fringe of moderate length. Venation: m-cu close to fork of M, the cell 1st M_2 elongate, subequal to or longer than vein M_{1+2} beyond it.

Abdomen with the tergites black, the sternites in male chiefly light yellow, variegated on sides by darker; sternal pocket and hypopygium black; abdomen in female black throughout but the dark coloration of sternites probably caused by internal discoloration; genital shield and hypovalvæ black, cerci horn-colored.

Habitat.—Japan (Loochoo Islands).

Holotype, male, Iriomote Island, August 20, 1934 (*Gressitt*). Allotopotype, female, August 21, 1934.

The nearest ally is *Teucholabis* (*Teucholabis*) *yezoensis* Alexander (northern Japan), which differs most evidently in the orange-yellow knobs of the halteres, the chiefly yellow posterior femora, and the variegated abdominal tergites. The present fly is entirely different from the three species of the subgenus so far discovered in Formosa.

GONOMYIA (PTILOSTENA) LONGIPENNIS sp. nov. Plate 1, fig. 19.

General coloration gray; scape and pedicel whitish, flagellum dark brown; wings tinged with brown, variegated with darker brown and light yellow; vein R_4 strongly recurved; cell 2d M_2 deep; abdominal tergites uniformly dark brown, the sternites light yellow.

Female.—Length, 6.5 to 7 millimeters; wing, 5 to 6.5.

Rostrum and palpi black. Antennæ with the scape and pedicel whitish; flagellum black, the verticils exceeding the segments in length. Head with the front white, the posterior portions of head dark brown, pruinose; posterior orbits slightly pale.

Pronotum and mesonotum dark gray; anterior lateral pretergites yellow; humeral region of præscutum vaguely brightened; pseudosutural foveæ dark brown; scutellum dark reddish castaneous. Pleura with the dorsal portions dark brown, including the dorsopleural membrane, the ventral portions, including the sternopleurite and meron, abruptly pale yellow. Halteres dusky, the knobs dark brown. Legs with the fore coxæ weakly darkened, the remaining coxæ and all trochanters pale yellow; femora yellow; tibiæ and basal two tarsal segments yellow, the tips weakly darkened; remaining tarsal segments black. Wings (Plate 1, fig. 19) tinged with brown, variegated with darker brown and light yellow; cells C and Sc, together with the wing apex, narrowly and abruptly yellow; dark brown areas at arculus, origin of Rs, m-cu, cord, stigma, and as a cloud near outer end of vein 2d A; a distinct paler brown wash in subapical field of wing, involving cells R_3, R_4, R_5, and 2d M_2; veins dark brown, pale in the flavous areas. Venation: Vein R_5 strongly recurved; cell 2d M_2 deep.

Abdominal tergites brownish black; sternites light yellow.

Habitat.—Japan (Loochoo Islands).

Holotype, female, Iriomote Islands, August 24, 1934 (*Gressitt*). Paratopotype, female.

The nearest relative is *Gonomyia* (*Ptilostena*) *teranishii* Alexander (Japan and China), which differs most evidently (in the

female sex) in the broader wings with vein R_1 less recurved and with cell 2d M_2 shallower, and in several details of coloration.

GONOMYIA (GONOMYIA) BIBARBATA sp. nov. Plate 1, fig. 20; Plate 3, fig. 36.

Antennæ dark throughout; cervical region, pronotum, and mesopleura entirely pale yellow, unmarked; mesonotal præscutum and scutum dark brown; scutellum yellow; knobs of halteres darkened; legs dark brown; wings with a faint grayish tinge, the stigma slightly darker; costal fringe long and conspicuous; Sc_1 ending about opposite one-third the length of Rs; m-cu close to fork of M; abdominal tergites uniformly dark brown; sternites yellow; male hypopygium with the gonapophyses symmetrical, each appearing as a slender rod with a recurved spine on outer margin before apex.

Male.—Length, about 3.5 millimeters; wing, 4.4.

Rostrum and palpi dark. Antennæ dark throughout; flagellar segments elongate, the verticils relatively conspicuous. Front yellow; posterior portion of head gray.

Cervical region and pronotum clear light yellow. Mesonotal præscutum and scutum almost uniformly dark brown, the median region of the latter a trifle brightened; scutellum clear yellow; mediotergite dark gray. Pleura and pleurotergite uniformly pale yellow. Halteres pale, the knobs darkened. Legs with the coxæ yellow; trochanters brownish testaceous; remainder of legs dark brown. Wings (Plate 1, fig. 20) with a faint grayish tinge, the stigma slightly darker; veins brownish black. Costal fringe long and conspicuous. Venation: Sc relatively long, Sc_1 extending about to opposite one-third the length of Rs, Sc_2 a short distance from its tip; basal section of R_{4+5} short to very short; m-cu close to fork of M.

Abdominal tergites uniformly dark brown, the sternites pale yellow; hypopygium with the basistyles chiefly pale yellow. Male hypopygium with the basistyles elongate, not produced into conspicuous outer lobes; dististyle single, broken in the unique type. Gonapophyses symmetrical, each appearing as a gently curved blackened rod, before apex on outer margin with a small spine or barb, directed slightly basad.

Habitat.—Japan (Loochoo Islands).

Holotype, male, Iriomote Island, August 20, 1934 (*Gressitt*).

The structure of the gonapophyses of the male hypopygium is quite different from any other species known to me. The costal fringe, while long, is not as conspicuous as in the allied *Gonomyia* (*Gonomyia*) *longifimbriata* Alexander (Mindanao).

GONOMYIA (GONOMYIA) FOLIACEA sp. nov. Plate 1, fig. 21; Plate 3, fig. 37.

General coloration of mesonotum brownish black, the posterior margin of scutellum yellowish brown; antennæ black throughout; thoracic pleura pruinose with white; knobs of halteres brown; legs obscure yellow; wings with Sc_2 ending nearly opposite midlength of Rs; m-cu some distance beyond fork of M; male hypopygium with the outer dististyle flattened, foliaceous, the tip an acute point, the entire surface with microscopic setulæ.

Male.—Length, about 5.5 millimeters; wing, 6.

Rostrum yellow; palpi black. Antennæ black throughout, the pedicel much enlarged. Head gray, the front and occipital portion more yellowish.

Cervical sclerites and pronotum yellow. Mesonotal præscutum chiefly brownish black, the humeral region lighter brown; scutum black; scutellum black basally, the outer portion paling to dull yellowish brown; mediotergite dark gray. Pleura heavily pruinose with white, the dorsal pleurites and ventral sternopleurite somewhat darker, the white color most evident as a very diffuse longitudinal stripe; dorsopleural membrane yellow. Halteres brown, the base of stem restrictedly pale, the knobs darker brown. Legs with the coxæ and trochanters brownish yellow to obscure yellow, the tarsi darker. Wings (Plate 1, fig. 21) with a faint darker tinge, the stigma pale brown; cells C and Sc somewhat clearer yellow; veins dark brown. Venation: Sc unusually long, Sc_1 ending about opposite midlength of Rs, Sc_2 a short distance from its tip; basal section of R_5 distinct; m-cu nearly half its length beyond the fork of M.

Abdominal tergites uniformly brown, the sternites yellow; hypopygium obscure yellow. Male hypopygium (Plate 3, fig. 37) with the outer dististyle, *od*, a flattened leaflike blade that narrows to an acute spinous point, the surface with abundant delicate setulæ; inner style, *id*, with a short basal lobe that bears two fasciculate setæ, additional to the smaller normal setæ; outer branch a narrow blackened rod, the tip very obtuse, near base with a few setæ and one conspicuous spine. Phallosome, *p*, complex, the gonapophyses black, subequal in length but apparently slightly asymmetrical in form.

Habitat.—Formosa.

Holotype, male, Sakahen, altitude 3,000 feet, July 16, 1934 (*Gressitt*).

Gonomyia (*Gonomyia*) *foliacea* is very different from all described regional species in the structure of the male hypopygium, notably the peculiar foliaceous outer dististyle.

ORMOSIA FUGITIVA sp. nov. Plate 1, fig. 22.

General coloration of præscutum pale testaceous, darkened medially; antennæ black throughout; halteres pale yellow throughout; legs obscure yellow, the terminal tarsal segments black; wings with the ground color milky, the stigma and a narrow seam along cord brown; m and M_3 not angulated at point of origin; anal veins strongly convergent.

Female.—Length, about 4.5 to 4.8 millimeters; wing, 5.5 to 5.8.

Rostrum and palpi brownish black. Antennæ black throughout; verticils long and conspicuous, much exceeding the segments. Head gray, with yellow setæ.

Mesonotal præscutum pale testaceous, darkened medially; scutum pale; scutellum and mediotergite dark plumbeous brown. Pleura dark plumbeous brown. Halteres pale yellow throughout. Legs with the coxæ dark plumbeous; trochanters obscure yellow; remainder of legs obscure yellow, the terminal tarsal segments black. Wings (Plate 1, fig. 22) with the ground color milky, the stigma brown; narrow but conspicuous brown seams along cord and fork of M_{1+2}, best indicated by darkenings of the otherwise pale veins. Trichia of membrane relatively short and inconspicuous. Venation: R_2 shortly beyond fork of R_{2+3+4}; m and M_3 not angulated at union; m-cu at fork of M; anal veins strongly convergent.

Abdomen dark brown.

Habitat.—China (Szechwan).

Holotype, female, Wei Chow, 65 miles northwest of Chengtu, altitude 9,000 to 12,500 feet, August 15, 1933 (*Graham*). Paratopotypes, 2 females.

Ormosia fugitiva is allied to *O. diplotergata* Alexander, *O. machidana* Alexander, and *O. takeuchii* Alexander in the pale wings, with vein R_3 not strongly upcurved at outer end and with m and outer section of vein M_3 not angulated at point of union. The species is well distinguished by the coloration of the body and wings, especially the narrow but distinct dark seam along the cord.

ERIOPTERA (PSILOCONOPA) PROPENSA sp. nov. Plate 1, fig. 33; Plate 3, fig. 38.

Allied to *bifurcata;* general coloration gray, the præscutum with three brown stripes; antennæ and legs black throughout; wings narrow, whitish, the stigma barely indicated; male hypopygium with the inner dististyle bifurcate, the apices of the arms nearly smooth; gonapophyses long and slender.

Male.—Length, 5 to 5.5 millimeters; wing, 6.3 to 6.5.

Female.—Length, about 6.5 millimeters; wing, 7.

Rostrum dark gray; palpi black. Antennæ black throughout; flagellar segments short-oval. Head gray, more brownish on disk.

Pronotum dark gray. Mesonotal præscutum gray, with three dark brown stripes, the median stripe in cases more or less split by a paler vitta; posterior sclerites of notum gray, the scutal lobes variegated by brown. Pleura clear gray. Halteres pale yellow. Legs with the coxæ clear gray; remainder of legs black. Wings (Plate 1, fig. 23) much narrower than in *bifurcata*, whitish, the prearcular region more yellow; stigma barely indicated by a brownish wash; veins dark brown. Venation as in *bifurcata*, but cells narrower due to the shape of wing, the differences especially noticeable in the anal field.

Abdominal tergites brownish medially, paling to gray on sides; sternites clearer gray; a series of linear blackish impressions along pleura. Male hypopygium (Plate 3, fig. 38) with the outer dististyle, *od*, a simple rod, the apex narrowed and blackened. Inner dististyle, *id*, bifurcate, the apices of both arms smooth or with scattered coarse denticles only. Gonapophyses much longer and more slender than in *bifurcata*.

Habitat.—China (Szechwan).

Holotype, male, Chengtu, altitude 1,700 feet, November 1, 1932, to March, 1933 (*Graham*). Allotopotype, female. Paratopotypes, 4 of both sexes, November 1, 1932, to May 10 to 14, 1933 (*Graham*).

The nearest ally is *Erioptera* (*Psiloconopa*) *bifurcata* Alexander (Japan), which is readily told by the broader wings and slight differences in the structure of the male hypopygium, notably of the gonapophyses. I doubt very much whether the subgenus *Ilisia* Rondani can be maintained as distinct from *Psiloconopa* Zetterstedt.

MOLOPHILUS INIMICUS sp. nov. Plate 1, fig. 24; Plate 3, fig. 39.

Belongs to the *gracilis* group and subgroup; general coloration of mesonotum grayish brown, the pleura darker; halteres uniformly light yellow; wings tinged with brownish gray, the stigma and vague clouds on cord slightly darker; anal veins elongate, converging apically; male hypopygium with all lobes of basistyle fleshy and obtuse at tips; ventral lobe with retrorse blackened spines; outer dististyle at apex dilated into a bispinous

scabrous head; inner dististyle an arcuated black rod, strongly bent at near midlength, with about four strong spines on concave face.

Male.—Length, about 4.3 millimeters; wing, 5.

Rostrum dark brown; palpi black. Antennæ of moderate length, if bent backward extending about to root of halteres, brown throughout; flagellar segments oval to long-oval, the verticils of the basal segments elongate. Head chiefly brown.

Mesonotal præscutum brown, more or less pruinose; anterior lateral pretergites light yellow; scutum and scutellum obscured in the type; mediotergite dark gray. Pleura and sternum brownish black. Halteres uniformly light yellow throughout. Legs with the coxæ and trochanters dark brown; femora obscure brownish yellow, the tips narrowly brighter; tibiæ brown; tarsi black. Wings (Plate 1, fig. 24) with a brownish gray tinge, the stigmal region and vague clouds on anterior and posterior cords weakly darker; prearcular and costal regions clearer yellow; veins brownish yellow; macrotrichia dark brown. Venation: R_2 lying shortly distad of level of r-m; m-cu sinuous, about one-half the petiole of cell M_1; anal veins elongate, convergent apically, narrowing cell 1st A before outer end.

Abdomen dark brown, the hypopygium a little brighter, brownish yellow. Male hypopygium (Plate 3, fig. 39) with all three lobes of basistyle blunt at tips, the dorsal lobe more slender, with pale setæ only; mesal lobe, *mb*, gently curved, with long black spines; ventral lobe, *vb*, broad, with about sixteen to eighteen retrorse black spines. Outer dististyle, *od*, a slender black rod, the apex dilated into a bispinous head, the surface surrounding these spines with microscopic scabrous points. Inner dististyle, *id*, a little longer, appearing as a relatively slender black rod that is bent almost at a right angle, narrowed to an acute point, the base with a few small pale tubercles, each tipped with a weak seta; bend of style on concave face with about four strong black spines.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 10,800 feet, August 18, 1934 (*Graham*).

Molophilus inimicus is very different from the other regional species of the genus. It is most generally similar to *M. crassulus* Alexander, but all details of the hypopygium are quite distinct.

ILLUSTRATIONS

[Legend: *a*, Aedeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *id*, inner dististyle; *mb*, mesal lobe of basistyle; *od*, outer dististyle; *p*, phallosome; *s*, sternites; *t*, tergites; *vb*, ventral lobe of basistyle; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Ptychoptera clitellaria* sp. nov., venation.
2. *Paracladura omeiensis* sp. nov., venation.
3. *Tipula (Formotipula) unirubra* sp. nov., venation.
4. *Nephrotoma biarmigera* sp. nov., venation.
5. *Nephrotoma evittata* sp. nov., venation.
6. *Nephrotoma caudifera* sp. nov., venation.
7. *Nephrotoma nigrostylata* sp. nov., venation.
8. *Phalacrocera minuticornis* sp. nov., venation.
9. *Limonia (Limonia) prudentia* sp. nov., venation.
10. *Limonia (Dicranomyia) veternosa* sp. nov., venation.
11. *Limonia (Rhipidia) monoctenia* sp. nov., venation.
12. *Antocha (Antocha) lacteibasis* sp. nov., venation.
13. *Hexatoma (Eriocera) ishigakiensis* sp. nov., venation.
14. *Hexatoma (Eriocera) iriomotensis* sp. nov., venation.
15. *Neolimnophila perreducta* sp. nov., venation.
16. *Gymnastes (Gymnastes) omeicola* sp. nov., venation.
17. *Gymnastes (Paragymnastes) mcleani* sp. nov., venation.
18. *Teucholabis (Teucholabis) iriomotensis* sp. nov., venation.
19. *Gonomyia (Ptilostena) longipennis* sp. nov., venation.
20. *Gonomyia (Gonomyia) bibarbata* sp. nov., venation.
21. *Gonomyia (Gonomyia) foliacea* sp. nov., venation.
22. *Ormosia fugitiva* sp. nov., venation.
23. *Erioptera (Psiloconopa) propensa* sp. nov., venation.
24. *Molophilus inimicus* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula (Formotipula) unirubra* sp. nov., male hypopygium, details.
26. *Nephrotoma biarmigera* sp. nov., male hypopygium, details.
27. *Nephrotoma evittata* sp. nov., male hypopygium, details.
28. *Nephrotoma definita* sp. nov., male hypopygium, details.
29. *Nephrotoma caudifera* sp. nov., male hypopygium, ninth tergite.
30. *Nephrotoma caudifera* sp. nov., male hypopygium, details.
31. *Nephrotoma nigrostylata* sp. nov., male hypopygium, details.

PLATE 3

FIG. 32. *Limonia (Limonia) prudentia* sp. nov., male hypopygium.
33. *Limonia (Dicranomyia) veternosa* sp. nov., male hypopygium.
34. *Limonia (Rhipidia) monoctenia* sp. nov., male hypopygium.
35. *Antocha (Antocha) lacteibasis* sp. nov., male hypopygium.
36. *Gonomyia (Gonomyia) bibarbata* sp. nov., male hypopygium, gonapophysis.
37. *Gonomyia (Gonomyia) foliacea* sp. nov., male hypopygium.
38. *Erioptera (Psiloconopa) propensa* sp. nov., male hypopygium.
39. *Molophilus inimicus* sp. nov., male hypopygium.

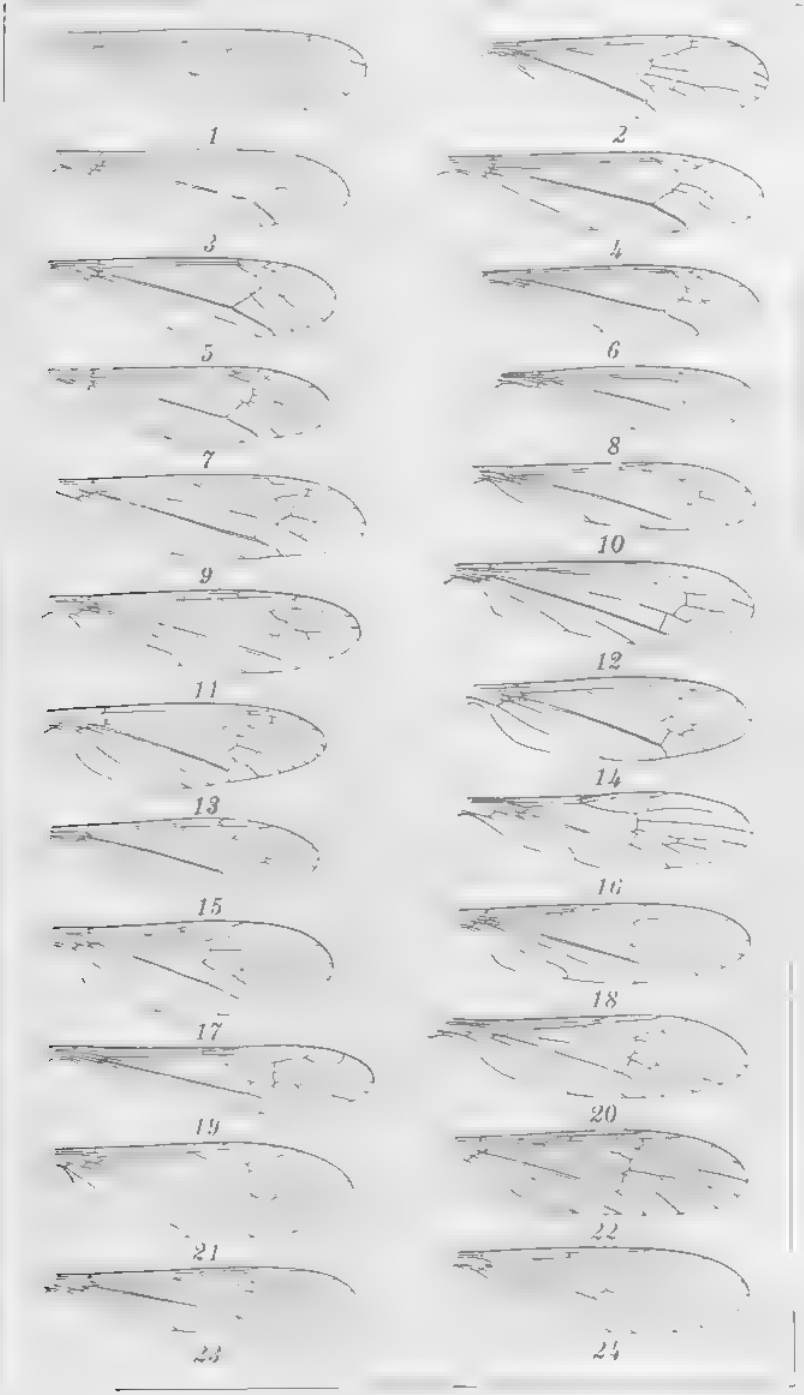
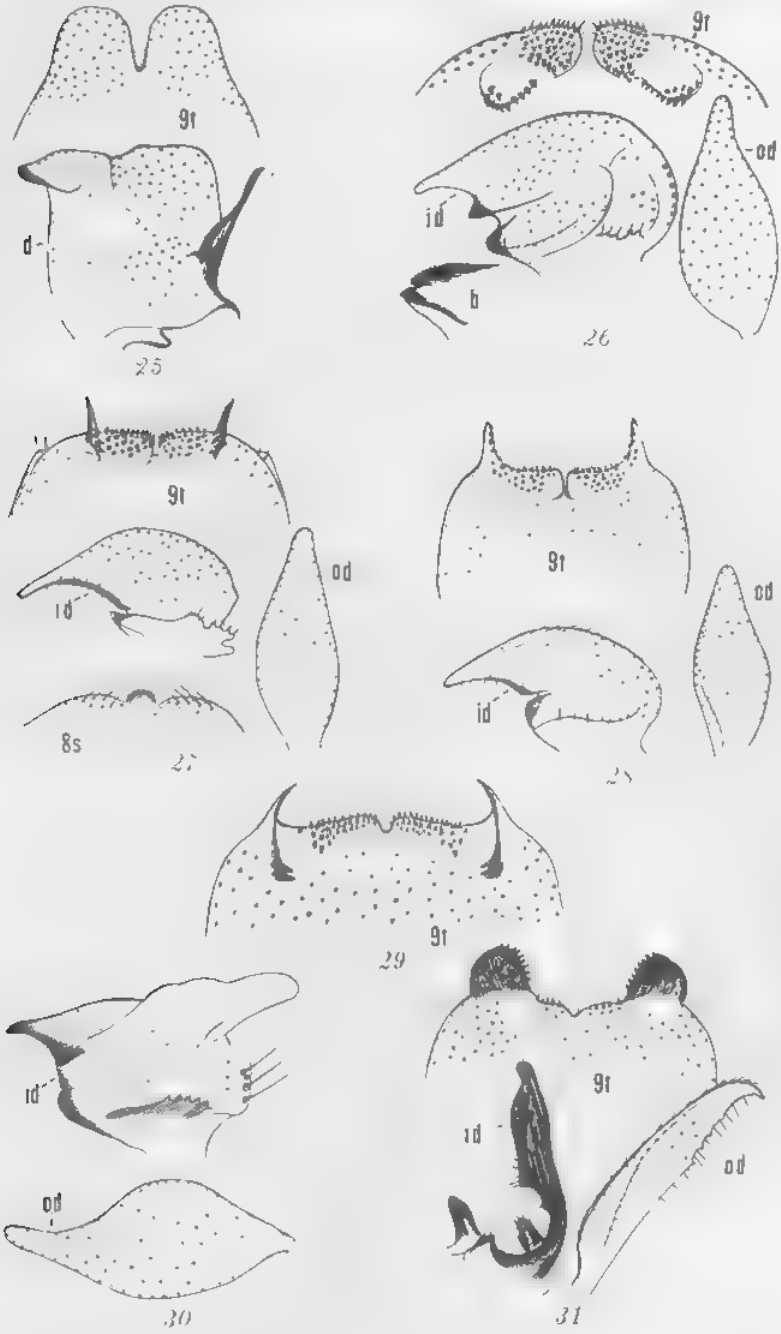


PLATE 1.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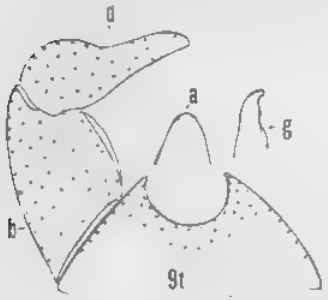

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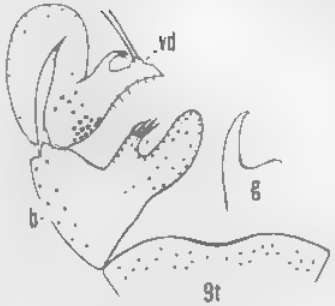

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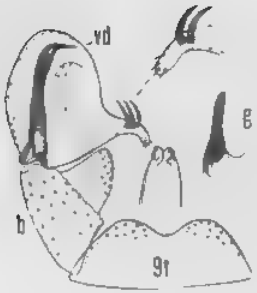

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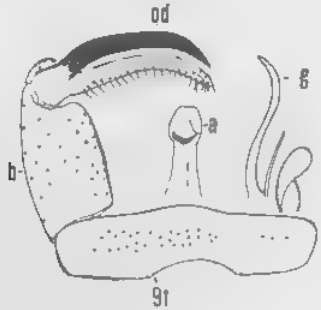

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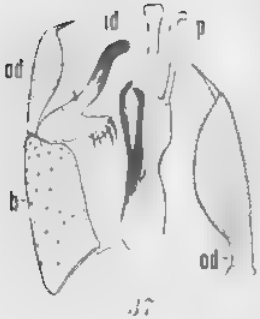

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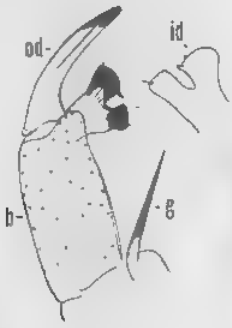

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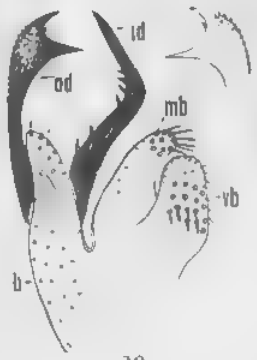

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PLATE 3.

GEOLOGY OF THE WHITE-CLAY DEPOSITS IN SIRUMA PENINSULA, CAMARINES SUR, LUZON

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ONE PLATE

INTRODUCTION

White clay has been used for a long time in several isolated localities in Camarines Sur, Luzon, for whitewashing houses, but its occurrence in Siruma Peninsula had not been reported to the Bureau of Science until the beginning of the hectic mining boom of 1933. Mr. Abarquez was sent out to confirm this report, and in May, 1933, after a three-day reconnaisance, he found a deposit in Sitio Napu, which he estimated to contain about 1,000 tons of white clay. Tests made by the ceramic laboratory of the Bureau of Science showed that this clay was the most refractory of all the local materials submitted so far to the Bureau of Science, that it could be put easily in suspension and was well adapted for casting such objects as bowls, saucers, and floor tiles, that it could well be used as a substitute for imported fire bricks, and that it might prove to be a good material for the manufacture of various other articles that are being imported into the Philippines to the amount of hundreds of thousands of pesos every year.

On the strength of these results, a recommendation was made to His Excellency, the Governor-General of the Philippine Islands, to reserve the Siruma clay deposit in order to avoid the harmful effects of speculative manipulation of the source of raw material for a ceramic industry in the Philippines. Accordingly Proclamation No. 583 was issued by the Governor-General January 5, 1935, reserving "All that area bounded by north latitudes 13 degrees 55 minutes 30 seconds, and 14 degrees 2 minutes 30 seconds and by east longitudes 123 degrees 15 minutes 45 seconds and 123 degrees 20 minutes 00 seconds." This reservation includes most of the valuable clay deposits, but it would be desirable to move the eastern boundary about one kilometer to include the Sulpa clay deposit.

In order to secure further data on the geology of the Siruma clay, the writer made a reconnaisance of Siruma Peninsula, from April 24 to 30, 1934, inclusive. He obtained his field notes and located them through the use of traverse lines, which he ran along the coast of Sapenitan Bay, Butauanan Bay, and Butauanan Island, along the trail from Tandoc to San Vicente, thence to Sulpa, and from San Vicente to Siruma, Suguitan, Sulpo, and Cabuyuan. These traverse lines were controlled by pace and Brunton compass and adjusted to the Coast and Geodetic Survey map, which was used as a base. A few details obtained from the map of the Cadwallader Gibson Lumber Co. were incorporated.

LOCATION AND ACCESSIBILITY

Siruma Peninsula is the northwest end of Caramoan Peninsula from which it is almost entirely separated by Looc River and San Vicente Bay. It is located on the east side of the mouth of San Miguel Bay and may be reached from Manila by the Manila Railroad as far as Naga, thence by automobile or bus as far as either Calabanga or Manguirin, from which small motor boats and launches make more or less regular trips to Siruma, Tandoc, San Vicente, and some other barrios, depending on the cargo and passengers available.

The trip from either Calabanga or Manguirin to Siruma Peninsula should not take over three hours by water, but since the launches stop in many small places to collect cargo and passengers, it sometimes takes more than twenty-four hours to cover the distance.

CULTURE

In Siruma Peninsula there are no roads but there are a few open foot trails and several kilometers of railroad tracks belonging to the Cadwallader Gibson Lumber Co. These tracks are being extended to cover the company's lumber concession in Siruma Peninsula.

Siruma is the only municipality in Siruma Peninsula, but Tandoc, being the site of the sawmill of the Cadwallader Gibson Lumber Co., is the most important sitio. It has a labor population of over 1,000 people, living in a camp, or small village, built by the company along the southwestern shore of Butauanan Bay.

At the end of the railway in Tandoc a wooden pier has been built to accommodate ocean-going steamships, which carry lumber to the United States.

TOPOGRAPHY AND VEGETATION

Siruma Peninsula is covered with rolling hills separated by narrow valleys in the central part of the peninsula and by open and swampy ones near the coast. The highest hill or mountain is about 70 meters high, and the average relief is about 30 meters. The coast is deeply indented by shallow bays and sharply protruding and narrow peninsulas. It may be inferred from the outline of the coast and the occurrence of sunken valleys like that of Looc River, San Vicente Bay, and the upper portion or head of Butauanan Bay that this peninsula has recently submerged.

Near the northern and western coasts the hills are generally covered with cogon grass on their flanks, and capped with forest. In the central part of the peninsula the hills are thickly covered with virgin forest which is the source of lumber supply of the Cadwallader Gibson Lumber Co. Most of the coast is bordered with mangrove near the river mouths and with white sandy beach between them.

GEOLOGY

The country rock in Siruma Peninsula is andesitic basalt in different stages of schistosity. The trend of the schistosity varies in different places and is generally at right angle to the coast line. In the greater portion of the peninsula the original rock cannot be distinguished, partly due to its complete metamorphism into schist, and partly due to weathering. Due to the latter the hills have been rounded by erosion and from a distance the topography resembles that of a shale country.

Along the creeks and trails numerous floats of white and coarsely crystalline barren quartz occur. They look more like cavity fillings or lenses than like vein material.

Along the railroad tracks in Siruma Peninsula zones of light-colored schist that alters into white clay occur. These zones are narrow and of limited extent, but rather frequent and are probably the source of the clay deposits that have accumulated in the valleys.

In Suguitan and Cadangan Creeks, near San Vicente, there are outcrops of white crystalline limestone, which is generally green on the surface due to a thin moss growth. This limestone is confined along the channels and banks of the creeks and is probably the inland extension of the coquina beds, which are in the course of formation along the coasts of Siruma Peninsula.

Long stretches of such coquina beds may be seen, particularly along those portions of the coast of Butauanan Bay and Butauanan Island that are not exposed to strong wave action. These beds dip about 5° toward the sea, and their strike is parallel to the contour of the coast.

WHITE CLAY

Four places are now definitely known where white-clay deposits of probable commercial size occur; Napu, Suguitan, Cabuyuan, and Sulpo. They may be briefly described as follows:

The Napu clay deposit.—This deposit was visited by Mr. Ramon Abarquez in May, 1933. It consists of several small deposits located along a tributary to Bahao Creek, about one hour's walk southeast of the town of Siruma (4.68 kilometers south 56 east, to be exact). Several pits have been dug in this place, which showed a deposit of white clay covered with an overburden of reddish ferruginous soil. The white clay becomes mottled with depth. It may amount to over 1,000 tons at least, according to Mr. Abarquez's preliminary calculations.

The Suguitan clay deposit.—The deposit in Suguitan is located on the banks of Suguitan Creek, about 1 kilometer southwest of the barrio of San Vicente. The clay is white to slightly gray and plastic and contains varying amounts of fine quartz sand. The deposit from which our sample was taken is evidently alluvial and has been washed down from the nearby hills. The mud that has been smeared over the bushes and grass by the carabaos whitens on drying, suggesting that it is of the same nature as the clay found down the creek. This fact leads us to presume that the clay deposit may extend to the hills, where the carabao mud holes are located.

The Cabuyuan clay deposit.—In Cabuyuan Creek the clay deposit is found along the banks, about 200 meters from Bahao River, into which the creek flows, and about 3 kilometers west of San Vicente, near the railroad track of the Cadwallader Gibson Co. This locality is low and is frequently flooded, the average elevation being barely 5 meters above the creek. The deposit may have a lateral extension of 300 meters square covering both sides of Cabuyuan Creek.

The clay is from white to slightly gray, highly plastic, and contains a small proportion of fine white sand. The plasticity seems to decrease with the amount of sand.

The Sulpo clay deposit.—The Sulpo deposit is located about 1.5 kilometers north-northeast of San Vicente along the banks of Sulpo Creek and near the trail to Diniagan. It is in a flat country with an elevation of about 6 to 10 meters above the creek and covers an area about half a kilometer square. Our sample was obtained from pits that were dug at the bank of the creek by people who used the clay for whitewashing their houses. The deposit is an alluvial mantle covered with a loam overburden 50 to 100 centimeters thick.

The Sulpa clay deposit.—The deposit in Sulpa is located about 2 kilometers north-northeast of the Sitio of Sulpa. It is a small deposit that has been washed down from the hills and has accumulated in the valley of Mayboclod Creek, a small and narrow valley that may be reached by way of an overgrown foot trail. This clay deposit is probably of limited extent as shown by the fact that only outcrops of solid schist occur on the hill sides and along the creeks and trails. The clay is whiter than that found in Suguitan, Sulpo, and Cabuyuan Creeks, and contains fine quartz sand, which makes it gritty.

COST OF MINING AND TRANSPORTATION

The cost of digging the clay samples that we brought to Manila was 2 pesos per sack of an average weight of 93 kilos, placed in San Vicente. The freight on the Manila Railroad to the Tutuban station was 3.85 pesos for a lot of six sacks, or 64 centavos per sack. To this must be added the cost of two gunny sacks, 30 centavos, the transfer from San Vicente to Naga, 79 centavos, and truckage in Manila, 76 centavos per sack, bringing the total cost of placing a sack of 93 kilos in Manila to 4.49 pesos. Two gunny sacks were necessary to hold the clay as they rotted quickly due to the moisture of the clay and could not stand its weight.

If every item in this estimate were proportional to the weight of the clay, 1 metric ton of it would cost about 48.30 pesos delivered in Manila. However, this figure is based on the mining and transportation of a lot of six sacks, the transfer of which between San Vicente and Naga was very expensive due to the very irregular route over which the clay was carried by carabao-drawn sled from the clay deposits to the canoe landing in San Vicente, by canoe to the head of Looc Bay, by launch to Kalabanga, and by truck to Naga station. It can be seen, therefore,

that there is room for simplifying the transportation and reducing its cost. For instance, it probably would be much cheaper to transport the clay in large lots directly by water on chartered freighters or sailboats from Siruma to Manila. There is also the possibility of reducing the cost of mining, which in the case of the Siruma clay amounts to mere digging, to within 1 peso per ton. By reducing mining and transportation costs, it may be possible to reduce the cost of 48.30 pesos, which we have obtained above, to less than 15 pesos.

CONCLUSION

The clay deposits in Siruma, as stated above, are of alluvial origin and of mantle form. That the deposit may extend in depth below the level of the creeks or even below sea level in some locality is possible, as there may have been deposition of clay before the recent subsidence of Siruma Peninsula. The possibility of clay in Siruma is that of many small deposits scattered over a wide area. While their areal extent and depth are not fully determined, it is very probable that an aggregate of at least 15,000 tons of clay may be available from the different deposits which are known at present.

Actual development work by digging exploratory pits and trenches or boring holes with auger or post-hole diggers at the Napu, Suguitan, Sulpu, and Cabuyuan deposits will have to be made to arrive at definite figures. For this work an outlay of 5,000 pesos should be sufficient, excluding the salary of a supervising engineer.

ILLUSTRATION

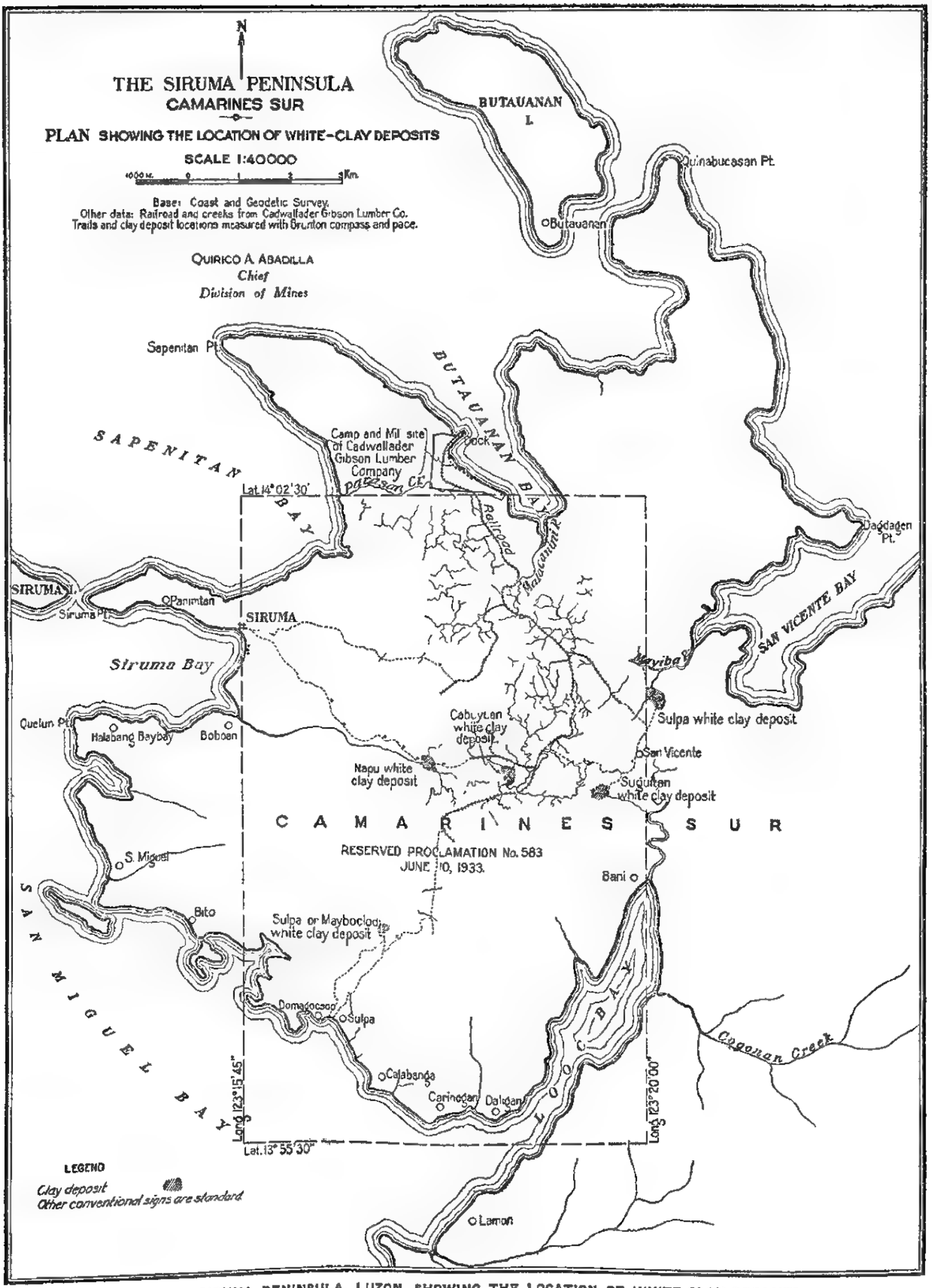

PLATE 1. SIRUMA PENINSULA, LUZON, SHOWING THE LOCATION OF WHITE-CLAY DEPOSITS.

THE DUMAGATS OF FAMY

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FIVE PLATES

INTRODUCTION

Investigations conducted by many authorities on the Philippine people have shown that the present civilized peoples of the Philippines, those now called Filipinos, are not really native to the Islands. The ancestors of the present Filipinos came from across the seas and settled in the Islands. These ancestors were in a rather high stage of civilization, and found in their new home an aboriginal people in the lowest stage of culture.[1] Naturally, the new-comers had the upper hand, and upon making their homes drove the aborigines from the shores and rivers that had been their homes into the interior.[2]

Hundreds of years elapsed, during which the Chinese came in junks and traded occasionally with the new-comers.[3] In 1521 the Spaniards discovered the Philippines and claimed them in the name of the King of Spain. The civilization they found had already risen to a comparatively high stage. The Malays had brought with them the art of writing from across the sea, and now had written records and documents. The missionaries, however, in their excessive zeal to implant the Christian faith among them, destroyed such writings as traces of paganism.[4]

As time passed, the aborigines were driven into the mountains by the growing population of the new-comers thriving under Spanish rule and culture. From that time to the present, these aborigines have dwelt in the mountains or along desolate

[1] Barrows, David P., History of the Philippines 7–11.

[2] Fernandez, L. H., A Brief History of the Philippines 2.

[3] Fernandez, L. H., op. cit. 89–90; Craig, Austin, The Former Philippines Thru Foreign Eyes 144–145; Barrows, David P., op. cit. 33.

[4] Craig and Benitez, Philippine Progress Prior to 1898, 77.

seashores, hardly getting in touch with the civilized people of the lowlands except for trading purposes, and barely rising from their primitive culture. They are scattered all over the Islands in the Cordilleras, Sierra Madre Range, and in some portions of the mountains of the southern islands. They live mostly by hunting and fishing. Those living near civilized people are gradually absorbing civilization; some of them are at present discarding their loin cloth for trousers, and beginning to wear undershirts to clothe the upper portion of the body. Some have even gone as far as to use matches from the towns in the lowlands. The Dumagats treated in this paper form one group of these aborigines.

GEOGRAPHIC DISTRIBUTION OF THE DUMAGATS

The Dumagats include but a very few of the non-Christian tribes in Luzon, each group being made up of only a few families.

They are widely distributed in the part of the Sierra Madre Mountains (Plate 5) near the small town of Famy, in Laguna Province. The rest of their kin are scattered there and in the mountains of Santa Maria (also a part of the Sierra Madre Mountains), Baler, Polillo, Mauban, and in Nueva Vizcaya Province.

Some of them are also located in the Kalawat Islands, and other small islands off the northern coast of Camarines.[5]

At present, the steady movement of the Dumagats is toward Nueva Vizcaya Province on account of the homesteaders, who are slowly driving them away from the regions they now inhabit. One word, however, must be said pertinent to this statement. It must not be inferred that the Dumagats are a nomadic people in the strict sense of the word.

> The Dumagat is not a true nomad but moves about, having more or less fixed camping places within a somewhat restricted area to which he claims ownership . . .[6]

If we attempt to investigate thoroughly the places mentioned and quoted in the preceding paragraph we will not find these people in large numbers, for seldom do they stay very long in a place.

[5] Beyer, H. O., Population of the Philippines in 1916. Philippine Education Co., Manila (1917) 42.

[6] Turnbull, W., The Dumagats of northeast Luzon, Philippine Magazine, Philippine Education Co., Manila (August, 1929) 131.

THE TOWN OF FAMY

A quaint, curious little community is the town of Famy, situated near the northeasternmost limits of Laguna Province (Plate 5), bordered on practically all sides by huge mountains of the Sierra Madre Range. Beyond the mountains northward lies the neighboring town of Santa Maria, which is the most remote municipality of the province in that direction. It is not very easy to traverse the distance between the two towns, in spite of their proximity, for the topography prevents the construction of a straight road. Hence, all transportation has to be circuitous. Eastward on the other hand, lie the mountains that separate Laguna from the adjacent Province of Tayabas. Only foot trails, well-known to the sturdy mountaineers, connect the two provinces with one another; sometimes travelers less versed in the geography of the country are obliged to hew their way through the forests in order to reach the seacoast of Tayabas.

As shown on the map Famy can be reached only over an unimproved road. The forking of the road is at the town of Siniloan, which lies south of Famy; consequently one traveling from Famy to Santa Maria has to go south to Siniloan and enter the main thoroughfare in the northwest direction up to the town of Mabitac before finally turning northward to reach Santa Maria. There is no direct road connecting Famy and Santa Maria because of the highlands between the two towns. However, there are foot trails, which are known only to sturdy mountaineers. For this reason planters are just beginning to take an active interest in the vicinity of this town and to cultivate its fertile soil for coconuts. Patches of coconut trees and numerous *kaiñgins,* or clearings, where camotes and other similar crops are planted, may be seen now rising from the place.

The very location of Famy, then, is not conducive to progress. Although all other *baybay* towns[7] have made remarkable advances both in wealth and in culture, Famy lags behind, handicapped by the limited access to traders.

[7] The "baybay towns" are those municipalities bordering the eastern shore of Laguna de Bay, the name *baybay* meaning "coast or shore." Hence, shore towns. Famy is still called a *baybay* town though it is rather too far inland to be termed one.

The municipality is not populous. A census [8] of the inhabitants reveals that the town and all its outlying barrios have a general population of only 1,095. Of these, 535 are males and 560 females. Within the confines of the town—that is, excluding the barrios—the population runs down to 965, of which 464 are males and 501 are females. The remaining 130 people living in the barrios are still apportioned among five districts, which are subdivided into still smaller parts. The numerous barrios are indicated in Table 1.[9] Each district is a unit represented by a Teniente del Barrio.

TABLE 1.—*The districts and their outstanding barrios.*

District No. 1:
- Panagarawan.
- Lucong.
- Talaga (sitio).
- Calumpang.
- Batuhan.
- Buhay.
- Palacio.

District No. 2:
- Llabac.
- Suncasuncahan (sitio).
- Kapatalan.
- Naga.
- Mayatba.
- Isabela (sitio).
- Daan Corte (sitio).
- Salang Bato.

District No. 3.
- May-init.
- De Castro.
- Pagkakabitan.
- Dapi.
- Malaking Bundok (sitio).
- Bulihan.
- Parusa.
- Palo (sitio).

District No. 4:
- Cuevang Bato.
- Lilian.
- Paritulot.
- Kulong.
- Tucorlangit.
- Balitoc.
- Daan Carga.
- Dorongawan (sitio).
- Sahor-olan.

District No. 5:
- Malico.
- Maate.
- Bacong.
- Minayutan.
- Katay-puanan.
- Sapang Pilaway.
- Cortadilla.
- Timbugan (sitio).

The Tagalog names of the barrios are derived either from the chief characteristic of the place or from an event that has happened there. *Talaga*, for instance, suggest the presence of some wells in the barrio; *Calumpang*, the presence of a calumpang tree; *Batuhan*, that the region is rocky; *Suncasuncahan*, that the ground is filled with hollows; *Dapi*, that there is a kind of soft stone in the barrio; *Parusa*, that somebody was tortured there; *Cuevang Bato*, that there is a stone cave in the place;

[8] The Philippine Census, Bureau of Printing, Manila 2 (1918) 173, Table 4.

[9] Municipal records of Famy.

Kulong, that the barrio is cut off from others by natural barriers; *Dorongawan*, that the place commands a lofty view of the surrounding barrios; *Sahor-olan*, that the place is hollow and is filled with water whenever it rains.

ORIGIN OF THE TERM DUMAGAT

The people now designated by the name Dumagat formerly dwelt along the shores of the Pacific Ocean, the chief source of their subsistence naturally being the sea. Hence, they earned the name Dumagats, which translated into English, literally means "Sea People"—a term also signifying their dependence on marine products. When interviewed, a number of them said: "We call ourselves Dumagats, or 'mga taga tabing dagat'—the people living near the seashore." They came from across the sea and upon landing on the coast made their homes there.

An intimate account of the life of the least known group of the people in the Islands—the Dumagats, the Sea People of the Northeastern coast of Luzon, believed to have come originally from New Guinea.[10]

PHYSICAL CHARACTERISTICS

The Dumagats are of mixed blood; hence, they bear a close resemblance to the Aetas, a resemblance so close that their Christian neighbors are prone to designate them with the same name, by mistake. A more-detailed study of their physical characteristics, however, will reveal many important differences from the Aetas.

Physical type essentially Indonesian but nearly all individuals show marked Papuan characteristics.[11]

The Dumagats possess a dark skin, curly or very kinky hair in many instances, thick lips, and markedly flat noses. In stature they do not belong to the type that may be called short. The height of the male Dumagat of Famy varies from 4 feet 11 inches to 5 feet 6 inches. The females on the other hand vary in height from 4 feet 5 inches to 5 feet 3 inches. These people as a whole are fairly strong. In particular, they have very strongly developed thighs, by reason of the kind of life they lead.

In their everyday life they are industrious, lively, cheerful, superstitious, brave, kind, friendly, trustworthy, possess much

[10] Turnbull, W., op. cit. 132. [11] Beyer, H. O., loc. cit.

endurance to pain, and are honest in their dealings among themselves, with regard to the settlement of questions of land boundaries and property rights.

However, they are mentally and physically superior to the Aeta, whatever their ethnologic status may be.[18]

One of their outstanding qualities, which make them lovable, is their unrevengefulness and spirit of fair play. They will not strike at a person behind his back—unlike the Aetas, most of whom are sly and treacherous.

CLOTHING

The clothing of the men is very simple and primitive, consisting of a single loin cloth. The women, for their part, wear the tapis, a sheet of cloth wound about the body and fastened a little above the breasts. The cloth falls to a little below the knees. Both the loin cloth and the tapis are of native-grown cotton. Very often they are dyed bright red, for these people love red. Sometimes the men wear short cloth jackets.

At present, however, the Dumagats are undergoing a change in their mode of dress. The men are slowly learning to wear regular trousers and undershirts, while the women are beginning to wear sayas or skirts. This change can be explained by their more frequent contact with their Christian neighbors.

ORNAMENTS AND BODILY DECORATION

The Dumagats love to adorn their bodies in various ways. The most characteristic adornments of the men are bejuco rings encircling the arms, waist, and head. In their liking for gaudy show they stain their bejuco rings red.

A red belt of stained rattan is used by men and women. Both sexes use wristlets and the males armlets . . . The Dumagat's love of bright-colored adornment is not confined to any age. It begins with the small children who deck themselves out with colored berries and flowers, and is as intense in the old who will trade their souls for a varicolored bead necklace or bit of scarlet cloth.[19]

On special occasions, they fasten fragrant leaves or flowers on these rings. Even marine shells are, to some extent, employed to decorate the bejuco rings. The women wear masses of beads around their necks and long strips of cotton cloth, dyed red as usual, wound around their waists. They gather their hair in a knot at the back of the head, and tie around it bands of *nito*.

[18] Turnbull, W., op cit. 131. [19] Turnbull, W., op. cit. 132.

Tattooing is also known and practiced, though not very extensively. They call this process *cadlet*. The pigment they use is pulverized charcoal only, unlike other tribes, which employ various colors. They simply puncture the skin with some pointed metal, introduce the pulverized charcoal into the punctures, and the process is over.

This fascination for show and decoration among the Dumagats is not confined to the adults alone, but also extends to the children. In fact, the love for adornment starts in the younger ones, who enjoy decorating themselves with flowers of various colors and small fruits, which they tie around their necks, their arms, and even their legs.

The Dumagats perform a few bodily mutilations, such as the filing of all front teeth between the canines, and, to some extent, circumcision. The latter is done, with either a bolo or a knife, on boys ranging in age from 3 to 15.

LANGUAGE

The dialect spoken by this semicivilized people is a curious mixture of the different dialects spoken by their Christian neighbors. The chief tongues intermixed in their speech are the Tagalog and the Bicol languages.

> Their present dialect is closely related to the Bicol language, though there are elements in it that are doubtless survivals of their ancient speech.[14]
>
> The dialect has some kinship to that of the Ilongots, but shows evidence of wide origin. It is of interest to note the use of many words found in the Bicol dialect . . .[15]

Instances where the mixture is very noticeable occur in the following conversation between a Dumagat suitor and a maiden:

> *Suitor:* "Ya kajatako sa alan yo kaiibig inmaadi kad sa dua yo. Iibara ko adsikamo, in wala din maadi kad sa dua yo ay kamamatay ko." (My purpose in visiting you is to reveal to you my feelings. If I shall be unable to tell you what these feelings are, I shall die.)
>
> *Maiden:* "Buksan idalaid sa dua mo at ng malapdan ko." (Tell them to me, so that I may know what they are.)
>
> *Suitor:* "Sumantala na pinabuksan idalad id sa adua ko ay hata at bubuksan ko. Ana kai ya at manambitan id gawang pagibig." (In as much as you consent to the revelation of my feelings towards you, I shall confess the affection that I hold for you.)
>
> *Maiden:* "Kadsan ko minsan matay kagsusulan ko ay wala ta ka man laang dakpan." (For me, I do not dare to listen to what you are telling me, even if you die in my presence.)

[14] Beyer, H. O., loc. cit. [15] Turnbull, W., op. cit. 131.

The mixture may be further illustrated in the study of their vocabulary and a typical Dumagat story of the Sun and the Moon. Some Dumagat words are:

Utak. Head.	*Mabuso.* Pain.
Buac. Hair.	*Paduro.* Thunder.
Nguso. Mouth.	*Dilap.* Lightning.
Ngipan. Teeth.	*Layolayo.* Far.
Kiret. Eyebrow.	*Apadnayo.* Near.
Talinga. Ear.	*Matungdo.* To sleep.
Alima. Arm.	*Kakarawang.* To jump.
Tuus. Upper leg.	*Talandang.* To run.
Bilies. Lower leg.	*Miuutas.* To fight.
Bagtaw. Chest.	*Mangan.* To eat.
Itutuyo. Finger.	*Umindom.* To drink.
Ewang. Sky.	*Sako.* I.
Dilag. Sun.	*Kahawa.* You.
Maningas. Moon.	*Aapatamo.* We.
Umbutatala. Star.	*Metbalaye.* They.

DILAG AT MANINGAS

Dilag at Maningas ay ibig magsabay kasipat. Kig minautas ay wala manalo Maningas. Kakasana isa ata ay wala id makapagpakibo idsera at wala manalo isa at ugnay malakas isa. Maningas ay sumipot ata metondo. Dilag ay sumipot lalagpon ata. Metalo Maningas ida Dilag at mayaga.

THE SUN AND THE MOON

(Once the Sun and the Moon wanted to shine at the same time for they had the same brightness. They made a bet on how they could make a man move. The Moon began to shine so the man went to sleep, but when the Sun shone the man began to work. The Moon was beaten so she gave up some of her brightness to the Sun.)

POLITICAL LIFE

The Dumagats, like most semicivilized peoples, have no definite and established form of political organization. They have, however, old customs and old traditions that have come down from their forebears from time immemorial. The chief of each tribe, who must necessarily be the eldest man in the group, is the supreme head, wielding absolute authority over his subjects, running a one-man despotic government. The principal duty that he is charged with is to see that strict obedience is given to the tribal customs. Usually he finds little or no difficulty in enforcing the law, for most tribes consist of no more than four or five good-sized families.

Upon the death of a chief, there is no election, nor struggle for the vacated post, but merely the automatic ascension of the next eldest member of the tribe to the chieftainship.

FOOD

The chief food consists mostly of sea and fresh-water products, which are supplemented with forest products, and the flesh of various animals such as monkeys, wild hogs, and birds. In order to trap these animals, the Dumagats place snares on the ground and on the trees. Their method of catching fish is, on the other hand, quite peculiar and typical of them. The women—they are usually the ones assigned to this work—dive under the water with the catapult, the dart, and the water goggles in order to facilitate their sight. They try to locate the holes at the bottom of the stream. Upon finding them, they thrust the dart into the holes by means of the catapult. Mudfishes and eels comprise the usual catch.

The principal item in their food is rice, supplemented with camotes, corn, root crops, bananas, and papayas, which are grown in their kaiñgins and backyards. They make a drink which they call *painot*, made by boiling the bark of *pugahan*, a kind of palm tree, in water.

HOUSING

The Dumagats, as we have seen, never stay long in one place, but move after a time to some other locality, the chief reason for their frequent migrations being the steady invasion of the homesteaders. Hence, upon settling in a place, they construct semipermanent homes requiring little effort.

The Dumagat house (Plate 4) is very small, low, and uncomfortable. It is made of small tree trunks, bamboo, rattan, and cogon grass. The type of architecture is the truss. Six stakes intended for posts are driven into the ground in two parallel rows. The middle stake in each row is almost twice the height of the other two, which are only as high as a man's waist. In the rectangular area formed by the two high and the low stakes, a flooring of bamboo strips is made. Then the roof is constructed over the entire structure. The roof is made of cogon grass arranged so that each section, beginning from the lowest part, is overlapped by the section above it. Bamboo strips and rattan are employed to keep the grass firmly in place. When the roof is finished, the two eaves almost reach the ground.

The open sides are covered with walls of cogon grass fastened like the roof except one part, which is left open to serve the purpose of a door. There is no window of any sort nor steps for access to the elevated floor; the occupants of the house sim-

ply clamber up without the aid of stairs. There is no furniture. The only thing to be seen in the interior is sometimes a trunk and a few household articles. Visitors have to sit on the bamboo floor. The reason for this is that the house is used only for sleeping purposes, all other activities taking place outside the house; even the stove is on the ground, formed by three stones, intended to support a cooking vessel. This stove, however, is seldom used, for the common way of cooking is to suspend the container from the roof of the house on the side not occupied by the floor, and to build a fire underneath it.

The Dumagats do not repair their homes. When the materials decay they do not change them. When the house begins to lean on one side, they simply prop it up with a bamboo post. They continue to live in it as long as it is fairly habitable, then build a new one either near the old one or on the adjoining kaiñgin.

FIRE MAKING

The Dumagats are just beginning to use matches. Most of them still cling to the primitive methods of kindling fire. They seldom resort to bamboo fusing; their principal method is the *pinkian*, wherein they employ flint and steel. The fine dried husk of the pugahan, a kind of palm tree, is placed on the flint, then the steel is struck against it. The resulting sparks from the contact ignite the husk. This is then blown till the flame increases.

IMPLEMENTS

Being mainly dependent on the sea for their subsistence, the Dumagats have need of but few implements. They have a unique fishing implement, something like a catapult (Plate 3, fig. 3). They possess simply bows, bamboo arrows, and small lances, which they deftly use in pursuing and catching wild hogs. In addition, they also use bolos and hatchets for building their houses and hewing trees.

UTENSILS

The Dumagats cook their rice and meat in bamboo tubes, one end opened, the other stopped by the joint. Bowls and cups they make from polished coconut shells. To carry water they employ long bamboo tubes six to twelve joints, all joints pierced through except the bottom or the last joint. Bamboos also serve for kitchen utensils and spoons. In the absence of bamboo containers, the Dumagats use the leaves of the anahao, a

kind of palm tree, for cooking rice. The leaves are shaped into a bowl, with the ends tied. This is not common among other Filipino tribes.

INDUSTRIES

The daily work of the Dumagats is directly connected with gaining their livelihood. They have few or no industries not immediately relating to the question of food. Although the women and some of the men fish, the catch is not sold but is consumed by the catcher and her family. A little basket and mat weaving is done. There is also some trade with the lowlanders in bejuco, vines, almaciga, and various other forest products, which they gather. Little agriculture is practiced, and here the kaingin system is employed. The Dumagats have absolutely no knowledge of pottery.

RELIGION

The Dumagats revere several anitos, but they do not acknowledge any supreme deity.

When some good fortune happens to them, the family and the group concerned in the matter sacrifice their domesticated animals, which they obtain from the Christians in the lowlands. The leftovers are offered to the spirits of their ancestors. The officiating priest (Plate 2) is the next oldest man to the chief. The chief himself never officiates in the sacrifice for good fortune.

FAMILY LIFE

The Dumagats are monogamous; the husband sticking to the woman of his choice faithfully throughout his life, except in case of adultery, which is very rare. The discovery of adultery usually results in the separation of the husband from the wife.

MARRIAGE

Marriage takes place among the Dumagats with or without parental intervention. The young men go through a period of courtship, during which they display their bejuco rings and armlets. The priest performs the marriage ceremony.

Among the well-to-do Dumagats the marriage ceremony is performed thus: The father of the bride-to-be invites ten expert hunters and sends them into the forest to hunt deer, wild boars, and monkeys. Upon their arrival from the hunt with their catch, the animals they carry are dressed and cooked.

The bride and the bridegroom are separated at the rear of the house, and around them are assembled the guests in two groups. Around the bride are gathered her immediate relatives, while around the bridegroom are gathered his. At the signal of the priest the two groups, one headed by the groom and the other by the bride, go around the house in opposite directions, till they meet at the doorway. Here the bride and the bridegroom shake hands as the priest tells them to do so. This performance completes the ceremony, and the couple is considered married.

Among the middle-class Dumagats the marriage ceremony is simple and unimpressive. The bride and the bridegroom are given buyo by the priest. They masticate it, then with the priest standing between them, they exchange their chewed buyo. After this they go as husband and wife.

Among the poor Dumagats there is no marriage ceremony of any sort. The girl simply goes to live with her lover, and they are considered husband and wife.

After their marriage the couple decides in which house they will reside. They may choose to live with their parents; in this case, they may live with the bride's parents for a few days, then, with the bridegroom's parents, and so on alternately. If the pair is able to live independently they build their own home or have their parents build a new house for them. If the parents die the couple lives independently.

CHILDREN

Ordinarily, the mother gives birth to her child in the home of her parents. There is no special house provided expressly for the expectant mother. The husband is most often present when his wife gives birth to a child, but the midwife who assists the mother during the period of labor is an old woman skilled in the work known as *hilot* in Tagalog. The mother never takes any precaution after she has given birth to a child. She resumes her duties in the home and outside the home.

The children receive their names when they reach the age of one year or more. The name is derived from that of a person the parents like, or whose name they like. It may also be the name of some small animal; in fact, the parents choose any name that fascinates them or they believe to be an appropriate one for their child. For instance, they may name a girl *Umadikit*, signifying lady, or *Umbutatala*, signifying star. These two names are popular among girls.

During infancy every boy and girl is given a nickname. This nickname then is the one by which they are known throughout life.

AMUSEMENTS

The Dumagats enjoy dancing and usually perform around a bonfire. They also sing love *kundimans*, and accompany the songs with the *kulibao* and the *subing*. The kulibao is made of bamboo. One joint is cut into a handle for the player. The joint connecting the handle with the main part of the strip is kept as it is, but the one at the further end is pierced. At the rounded surface between the two joints a large oval hole is made. Across it the dried skin of a monkey is stretched, as a drum, and fastened firmly. A stick about a foot long is secured. A low fulcrum for it is fastened near the edge of the stretched skin. The stick is then tied with a cord across the fulcrum in a leverlike manner, with the part toward the skin longer than the other, and in such a way that the longer end of the stick presses on the skin. To play the instrument, one simply taps rhythmically the raised end of the stick; this causes the other end to beat on the skin and produce a sound like that of a small drum.

The subing, on the other hand, is simply a flute made of small, long-jointed bamboo. The diameter is about one inch or even less. The closed end of the bamboo joint is used as stopper for that end. The holes, of which there are four to six, are drilled by means of red-hot iron pressed against the surface of the flute.

The Dumagats have a great love for music. While working, playing, or walking in the forest they sing to themselves. When a Dumagat wishes to call his neighbor to partake of some food or anything, he or she usually calls by means of songs. When a man sees a young woman approaching at a distance he sings a typical Dumagat song, the words running thus:

"Dano kaya nagmula aleng lenomewen amon nig dig momay iboy dasan pinalibutin?" (From what place does this lady I am perceiving come?)

The Dumagats have one game called *male*. This is played by the unmarried adults in the following manner:

Two groups of players, one made up of males and the other of females, line up on opposite sides some distance apart facing each other. One girl tosses an article into the space between the group. Immediately, one of the young men runs to it, picks it up, and joins the female group, where he is at once sur-

rounded by young women. After him dashes the entire male group, which invades the female and attempts to pull away the one carrying the article back to the ranks. If successful, their number is again whole, but if unsuccessful, it means that the female group has one captive, while the opposite group has one member lost. This time one of the male group tosses the article, and one of the female group runs to it, picks it up and joins the male group, just as the male in the first part of the game had joined the female group. The same procedure is followed; the female group runs and tries to wrest the girl from the men. This procedure continues alternately between the two groups up to an indefinite time till one group is thoroughly annihilated through the capture of all its members.

SICKNESS AND CURE

One of the peculiarities of the Dumagats is their way of viewing sickness. Unlike other primitive peoples, they do not seem to attribute diseases to evil spirits or anitos that they have inadvertently offended. Judging from their methods of curing or counteracting sickness, it appears that they regard disease as physical in nature. This is proven by the fact that they resort to some medicines; many of them use roots of trees, leaves, and fruits for this purpose. When they contract a chill, they plunge into the water with a glowing stick and remaining sitting at the bottom for a few seconds till they are relieved of the chill. Afterwards they come out of the water and dry themselves by the fire.

Skin disease called by them *bugis*, a Dumagat term for ringworm, is very common. Other diseases are stomachache and malaria. The latter sickness is accounted for by the fact that mosquitoes abound in the uncultivated forest in which the Dumagats live. The life of these people is generally unhygienic.

DEATH AND BURIAL

When death occurs it is usually caused by stomach pain and malaria.

The burial customs are rather peculiar. If a Dumagat dies he is buried in the very place where he has breathed his last. The house is destroyed next. There is no ceremony whatsoever.

Three days after the interment, the relatives of the deceased visit the resting place carrying offerings of rice, meat, and buyo; crying and wailing aloud.

They have no belief in the return of the spirits of the dead; they say that once a person dies, he will never come back; he is gone forever. For this reason they bring food and other offerings on the third day mentioned in order to supply the dead with sufficient provisions.

CONCLUSION

The Dumagats are a people still far below the standard of civilization attained by the civilized Filipinos. However, although they still cling steadfastly to the customs and traditions that they had when the Malays came over the sea and drove them into the interiors of the islands, they are by degrees adopting the first customs of modern civilization. They do not believe in the return of the spirits of the dead. Furthermore, they regard their sickness as physical in nature and hence resort to medicine.

From their mode of living and all that has been learned about them, it is safe to conclude that these people possess considerable intelligence and possibilities for improvement. Turnbull, in his article on the Dumagats of northeast Luzon, states that they are mentally and physically superior to the Ita, whatever their ethnologic status may be. Just as the introduction of public schools among the Igorots of northern Luzon is helping these people achieve a high state of culture, so will the establishment of public schools in the Dumagat communities aid them in absorbing modern civilization and enable them to perpetuate their race.

ILLUSTRATIONS

PLATE 1

FIG. 1. A Dumagat man, front view.
2. A Dumagat man, side view.
3. A Dumagat woman, front view.
4. A Dumagat woman, side view.

PLATE 2

FIG. 1. A Dumagat man, showing the peculiarity of his nose.
2. A Dumagat man, showing his loin cloth and his spear.
3. A Dumagat priest.
4. A Dumagat woman, showing her well-developed extremities.

PLATE 3

FIG. 1. A Dumagat mother and her daughter.
2. A Dumagat priest and one of his followers.
3. The catapult, the dart, and the goggles.

PLATE 4. A DUMAGAT HOUSE

PLATE 5

Map of a part of Luzon, showing where the majority of the Dumagats are found.

PLATE 1.

PLATE 2.

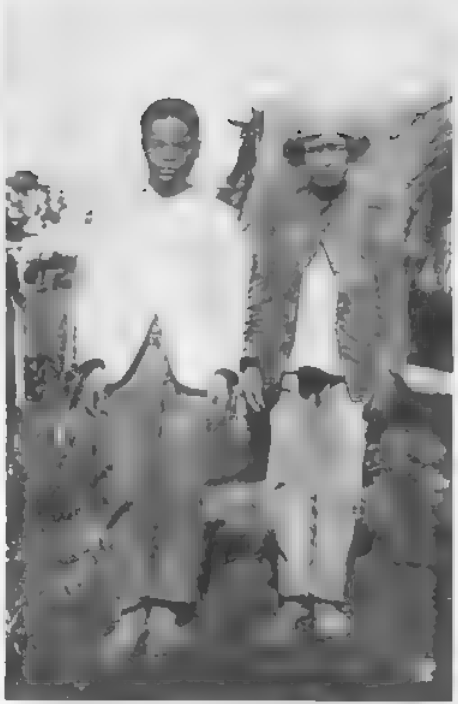

PLATE 3.

PLATE 4.

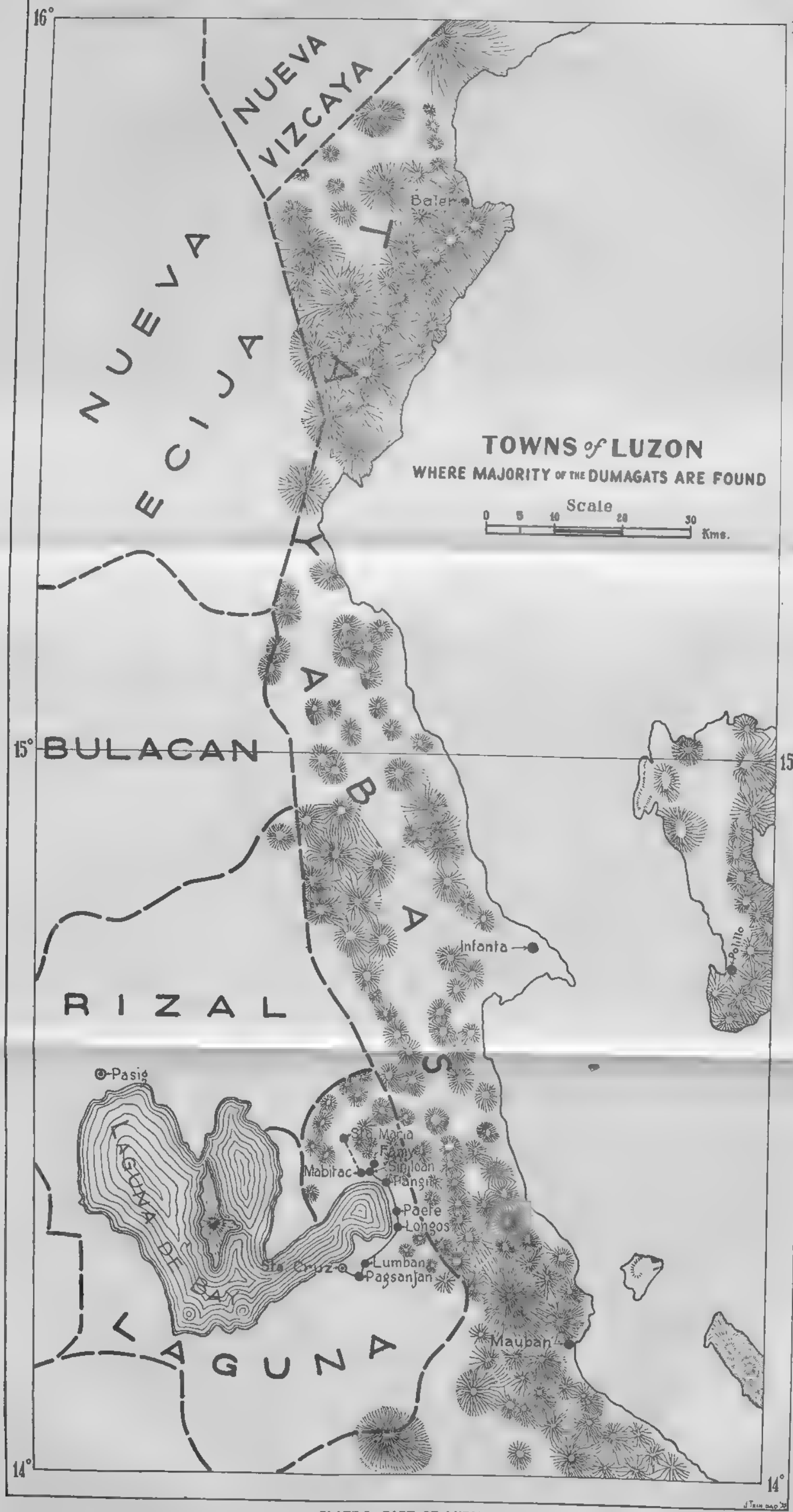

PLATE 8. PART OF LUZON.

HETEROPHYID TREMATODES OF MAN AND DOG IN THE PHILIPPINES WITH DESCRIPTIONS OF THREE NEW SPECIES.

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FOUR PLATES

The known Philippine parasitic fauna has been very poor in heterophyid flukes. Tubangui (1933), in a paper dealing with trematode parasites of Philippine vertebrates, listed only three species of heterophyid trematodes in this country; namely, *Ascocotyle pithecophagicola* from the small intestine of *Pithecopaga jefferyi*, *Haplorchis anguilarum* from the intestine of *Anguilla mauritiana*, and *Scaphanocephalus adamsi* represented by some immature forms encysted in the fins and under the scales of *Lepidaplois mesothorax*. This report enriches our heterophyid parasitic fauna by six species parasitic in the small intestine of man and dog representing four genera and two subfamilies of the family Heterophyidæ Odhner, 1914; namely, *Heterophyes*, *Stictodora*, and *Diorchitrema*, of the subfamily Heterophyinæ, and *Monorchotrema*, of the subfamily Haplorchinæ. Three of these six species are herein described as new, two which have been obtained from both man and dog are found to be identical with *Monorchotrema taichui* Nishigori, 1924, and *Diorchitrema pseudocirrata* Witenberg, 1929, respectively, and one which was also obtained from the small intestine of man is identical with *Monorchotrema taihokui* Nishigori, 1924. The three new species are *Heterophyes expectans*, from the small intestine of Manila street dogs; *Stictodora manilensis*, from the small intestine of the same animal; and *Heterophyes brevicæca* obtained from the small intestine of an adult Filipino from La Union Province, northern Luzon, autopsied in the Manila City Morgue. The last is of especial interest because it is the first human parasitic fluke discovered in the Philippines since Garrison's discovery of *Fascioletta ilocanum* (*Echinostoma ilocanum* Garrison, 1908) about a geneneration ago.

Five more specimens of *Heterophyes brevicæca* were recovered from the small intestine at the autopsy of an adult male Filipino, native of Candon, Ilocos Sur (adjacent to La Union), associated with *Euparyphium ilocanum* and another still unidentified trematode that appears to be a new species of *Lepoderma* Looss, 1899 (*Plagiorchis* Lühe, 1899).

HETEROPHYES EXPECTANS sp. nov. Plate 1, fig. 1.

Five specimens of this fluke were obtained from the small intestine of native dogs on four occasions.

Body small, leaflike, 2.1 mm by 0.4 mm. Cuticle with scalelike spines, thickly set anteriorly, scantier after middle of body. Oral sucker subterminal, 0.190 mm by 0.115 mm; prepharynx long and capillary; pharynx 0.12 mm in breadth, œsophagus short; intestinal cæcæ simple tubes extending beyond posterior border of hind testes. Ventral sucker close to intestinal bifurcation, 0.2 mm in diameter.

Female organs.—Ovary globular, 0.18 mm by 0.11 mm, median, midway between anterior testes and acetabulum; roundish receptaculum seminis close behind, 0.14 mm by 0.11 mm. Uterine coils fill entire body from most posterior extremity to seminal vesicle. Vitellaria consist of irregularly shaped follicles, almost extracæcal, or, at least, closely applied to lateral margin, rather long, extending from level of posterior testes to first portion of seminal vesicle.

Male organs.—Testes large, roughly globular, median, removed from posterior extremity of body and placed one behind the other almost in a straight line. Posterior testes, 0.340 mm by 0.295 mm, slightly larger than anterior one, which is 0.320 mm by 0.290 mm. Seminal vesicle consists of three dilatations separated from each other by short tubules; the first part of which, or the hindermost, being the largest, and the third or expulsor portion smallest and wedge-shaped, the pointed end being directed towards the center of the gonotyl where it apparently ends in common with the similarly shaped vagina.

Genital sac alongside of and posterior to the ventral sucker, a little to the left; in stained toto mounts the two organs slightly brush each other, but in fresh specimens they are entirely separate and independent structures. It has a transverse diameter of 0.130 mm and houses a well-developed, apparently protrusible gonotyl, which bears a crown of about 105 apparently chitinous rodlets in a single row.

Eggs 0.021 by 0.013 mm, symmetrically oval with distinct "shouldering" at opercular end.

Specific diagnosis.—Heterophyes: Size 2.1 mm by 0.4 mm, body leaflike; prepharynx long and capillary, pharynx large, 0.12 mm in diameter; œsophagus short; intestine simple tubes; acetabulum removed considerably anterior from equator, alongside but independent of the genital sac; ovary in the middle of the body directly anterior to anterior testes; vitellaria long, closely applied to the lateral margin of body; testes removed from the posterior end of body, one behind the other in a straight line; uterine coils extend beyond posterior border of hind testes to extreme posterior end of body; genital sac close behind acetabulum, a little to the left, filled by a mushroomlike, apparently protrusible gonotyl, which bears a circlet of about 105 rodlets; eggs, 0.021 by 0.013 mm.

Host.—Native dog.

Location.—Small intestine.

Locality.—Manila, Philippine Islands.

Type specimen.—Parasitological collection, School of Hygiene and Public Health, University of the Philippines.

Remarks.—Witenberg (1929), following a thorough revision of members of the family Heterophyidæ, has discarded many members of doubtful validity from the genus *Heterophyes*, and recognized as valid only three species of this genus; namely, *Heterophyes heterophyes* Siebold, 1852, *Heterophyes dispar* Looss, 1902, and *Heterophyes æqualis* Looss, 1902. All the rest with the exception of *Heterophyes nocens* Onji and Nishio, 1915, which he said required further study to establish its validity, are considered synonyms of either one or another of the surviving species. However, Lane (1929) seems quite definite that *H. nocens*, which is most likely identical with *H. katsuradai* Osaki and Azada, 1926, is synonymous with the type species *Heterophyes heterophyes*.

Our specimens differ from the three established species of the genus in that (*a*) their testes are removed from the posterior extremity of the body and placed one behind the other, whereas in the established species they are obliquely in the hindermost portion of the body; (*b*) the vitellaria in our specimens are long and closely applied to the lateral margin of the body, whereas in the established species they are short with median distribution of their follicles confined between testes and ovary; (*c*) the ventral sucker in our specimens is far removed anteriorly

from the equator, whereas in the established species it is in the middle of the body; and (*d*) the rodlets in the gonotyl of our specimens are much more numerous, being around 105. Therefore, we feel that this heterophyid is a valid species, which we name *Heterophyes expectans* because its appearance in this part of the Far East has long been expected.

According to Witenberg the genus *Heterophyes* is the only one of the family Heterophyidæ that has a ventral sucker independent of the genital sac. If this claim is valid, then our specimen belongs to the genus *Heterophyes*. However, the same author by arranging all the known genera of Heterophyidæ in a table in which those belonging to one subfamily are placed in longitudinal rows and each space in the transverse direction corresponds to a definite disposition of the testes, has been able to produce a table of homologous rows, in which the parallelism in the development of the features of the different subfamilies of Heterophyidæ is, according to him, clearly seen (Table 1, Witenberg's paper, 1929). In this table Witenberg left empty squares under the different subfamilies, which are intended for still undescribed genera whose main features, according to him, can be predicted. Now it seems that *Heterophyes expectans* would prove to be a test case for Witenberg's table of homologous rows, for here we have a fluke which aside from presenting many other established characters of the genus *Heterophyes*, has a ventral sucker independent of the genital sac, but which on the other hand has its testes one behind the other and removed from the posterior extremity of the body and rather long vitellaria. Following Witenberg's formula, *Heterophyes expectans* would align itself in the same space in the transverse direction with *Microlistrum* under the tribe Cryptocotylea with regard to the disposition of the testes and character of the vitellaria, but has to be retained under *Heterophyes* with regard to the structure of the ventrogenital apparatus, or it has to align itself in the same transverse space with *Apophallus* under the tribe Heterophyea with regard to the relative position of the testes to each other. Since the present material presents more of the character of *Heterophyes* than any other genus, it seems that this confusion can be averted by retaining it under the genus *Heterophyes* as we propose herein. In the event that the validity of *Heterophyes expectans* is finally established, certain characters of this group that have been assigned generic values have to play mere specific rôles.

HETEROPHYES BREVICÆCA sp. nov. Plate I, fig. 2.

Twenty-one specimens of this fluke were obtained at autopsy from the small intestine of a male Ilocano, 50 years old, native of La Union, Philippine Islands, who died in Manila of acute cardiac dilatation.

Body very small, 0.6 to 0.7 mm by 0.30 to 0.35 mm, pear-shaped; cuticle with scalelike spines more thickly set anteriorly than posteriorly. Oral sucker subterminal, 0.085 mm by 0.070 mm; ventral sucker slightly larger than oral sucker, 0.075 mm by 0.080 mm, postequatorial in the median line. Prepharynx three times the diameter of the œsophagus, pharynx oval, 0.035 to 0.040 mm by 0.035 mm, œsophagus long, intestines short but large, being from three to four times larger than œsophagus, their blind ends never extending posteriorly beyond the acetabulum.

Female organs.—Ovary globular, 0.075 to 0.080 mm by 0.060 to 0.065 mm, at about the same level as the acetabulum to the right side; receptaculum seminis close behind, concealed by the coarse vitelline follicles; uterine coils limited to the posterior half of the body, their terminal portion meandering along the left side anteriorly to end at the vagina, which runs towards the genital sac. Vitellaria consist of five or six large follicles (0.06 by 0.04 mm) on either side, which obscure the testes; the transverse vitelline duct very prominent, running like a bridge across the median field behind the acetabulum.

Male organs.—Testes globular or ovoid, 0.105 mm by 0.070 mm, removed considerably from the posterior extremity on the same level with the vitellaria, and on the same plane with reference to each other. Seminal vesicle very large, looped over on the anterior side of the ventral sucker, its first portion being the largest and most prominent, occupying almost the entire triangular space formed by the acetabulum and the intestines.

The excretory vesicle forks almost immediately into two large vesicular arms each of which after running along the posterior side of the body turns medially to send off a small tubule which runs vertically upward to the vicinity of the pharynx.

Eggs, 0.016 by 0.010 mm.

Specific diagnosis.—Heterophyes: Size 0.06 to 0.07 mm by 0.3 mm; body pear-shaped; cuticle with scalelike spines; prepharynx large, three times as large as œsophagus; pharynx ovoid; œsophagus long; intestines simple, very short, never extending beyond level of ventral sucker; acetabulum slightly

TABLE 1.—*Character differentiation among H. heterophyes (von Siebold, 1852), H. dispar (Looss, 1902), H. æqualis (Looss, 1902), H. expectans sp. nov., and H. brevicæca sp. nov.*

Character.	*H. heterophyes.*	*H. dispar.*	*H. æqualis.*	*H. expectans.*	*H. brevicæca.*
Size..... mm....	2.7×0.9	0.4–1.4×0.2–0.4	0.4–0.9×0.2–0.4	2.1×0.4	0.6–0.7×0.3–0.35
Pharynx.. mm	0.03–0.06	0.03–0.04	0.02–0.4	0.1	0.035–0.040×0.035
Œsophagus.....	Long.....	Long.....	Long.....	Very short.....	Long.
Intestines.....	Simple, reaching the posterior extremity of the body where they turn round the testes.	Similar to those of *H. heterophyes*.	Four or five times the diameter of the œsophagus, never extend beyond testes.	Similar to those of *H. heterophyes*.	Short, never extending beyond level of acetabulum.
Ventral sucker.....	About middle of the body.	About middle of the body.	About middle of the body.	Removed a considerable distance anteriorly from middle of body.	Postequatorial.
Genital sac.....	Almost as large as ventral sucker; gonotyl armed with 73–87 rodlets.	Does not exceed half of the diameter of ventral sucker; gonotyl bears 25–30 thin spines.	Somewhat smaller than ventral sucker; gonotyl with a circlet of 15–25 thin spines.	About half as large as ventral sucker; gonotyl with circlets of about 105 spines.	Genital sac about half as large as ventral sucker; gonotyl with circlet of spines, number undetermined.
Disposition of testes.	Obliquely in the hindermost portion of body.	As in *H. heterophyes*.....	As in *H. heterophyes*	One behind the other, removed a considerable distance from the posterior extremity of body.	Obliquely, removed considerably anteriorly from the posterior extremity of body.
Vitellaria.....	Short, confined between the levels of testes and ovary; mostly intracæcal.	Similar to that of *H. heterophyes*.	Similar to that of *H. heterophyes*.	Long, extending a considerable distance beyond the anterior border of ovary; mostly extracæcal, or at least closely applied to the margin of body.	Short, follicles few and very coarse, 5 or 6 on each side, confined in the region of testes, postcæcal, each follicle about 0.06 mm × 0.04 mm.

Uterus	Fills the whole free space between testes and ventral sucker; does not extend beyond these levels.	As in *H. heterophyes*	As in *H. heterophyes*	Extends behind testes to the extreme posterior end of body.	Confined between level of the acetabulum and posterior end of body.
Seminal vesicle	Posterior to acetabulum	Posterior to acetabulum	Posterior to acetabulum	Posterior to acetabulum	Anterior to acetabulum.
Ovary	Median and posterior to acetabulum.	As in *H. heterophyes*	As in *H. heterophyes*	As in *H. heterophyes*	On the right side of and on the same level with acetabulum.
Eggs mm	0.023–0.027×0.013–0 015	0.021–0.023×0.013–0.015	0.023–0.025×0.014–0.016	0.02–0.022×0.013–0.015	0 016×0.01

larger than oral sucker, 0.09 by 0.08 mm, postequatorial and median; ovary roundish, 0.075 to 0.080 by 0.06 to 0.065 mm, anterolateral to acetabulum; uterine coils fill posterior half of body; vitellaria consist of coarse follicles, 0.060 by 0.040 mm; testes ovoid, 0.105 by 0.070 mm, removed considerably from posterior extremity, on same level; seminal vesicle anterior to acetabulum, consisting of three saculations separated from each other by short tubes; genital sac separate and independent from acetabulum, to the right of the latter and housing mushroomlike gonotyl crowned with a circlet of rodlets; excretory vesicle horseshoe-shaped; eggs, 0.016 by 0.010 mm.

Host.—Man, native of La Union Province, Philippine Islands.

Location.—Small intestine.

Locality.—Manila, Philippine Islands (?).

Type specimen.—Parasitological collection, School of Hygiene and Public Health, University of the Philippines.

Remarks.—Compared with the established members of the genus *Heterophyes*, this fluke differs from any one of them as will be noted in our comparative table in the length of the intestines, in the position of the ovary and seminal vesicle, in the size of the vitelline follicles, in the form of the excretory vesicle, and the distance of the testes from the posterior end of the body. We name this new human heterophyid *Heterophyes brevicæca* on account of its short intestines.

STICTODORA MANILENSIS sp. nov. Plate 2, figs. 1 to 3.

Nineteen specimens of this fluke were obtained from the small intestines of two Manila street dogs.

Body small, 1.31 mm by 0.32 mm, oblong, all the reproductive organs contained in the enlarged posterior portion; cuticle spinous; oral sucker subterminal, 0.05 to 0.06 mm, prepharynx long, pharynx ovoid, 0.03 to 0.04 mm, œsophagus short, intestine simple tubes extending to the posterior end of the body. Ventral sucker present but rudimentary, incorporated with the genital sac at its anterior wall.

Female organs.—Ovary round, 0.095 by 0.080 mm, in front of the right testes; receptaculum seminis between the testes; uterine coils fill the posterior half of the body; vitellaria consist of rather small follicles arranged in transverse rows in the hind fourth of the body.

Male organs.—Testes transversely oval, obliquely one behind the other in third fourth of the body, posterior testes being slightly larger, 0.090 by 0.072 mm, than anterior, 0.062 by 0.061 mm;

vas deferens consists of three sacculations, separated by short tubes, located between the genital sac and the ovary.

Genital sac ringlike, 0.045 by 0.040 mm, preëquatorial, occupied completely by a pear-shaped protrusible gonotyl that bears at its tip a circlet of 12 to 15 chitinous plates resembling the hooklets of *Tænia;* that is, they are provided with handle, guard, and blade. Excretory vesicle Y-shaped.

Eggs, 0.025 to 0.026 by 0.014 to 0.015 mm.

Specific diagnosis.—Stictodora: Body small, 1.31 mm by 0.32 mm, oblong; both prepharynx and œsophagus prominent; ventral sucker present but rudimentary on the anterior wall of the genital sac; testes obliquely one behind the other in the posterior part of the middle third of the body; ovary anterior to the right testis; seminal receptacle between testes; uterine coils between the genital sac and posterior end of the body; genital sac filled by protrusible pear-shaped gonotyl which bears a crown consisting of a single row of 12 to 15 chitinous plates that resemble the hooklets of *Tænia;* excretory duct Y-shaped.

Host.—Native dog.

Location.—Small intestine.

Locality.—Manila, Philippine Islands.

Type specimen.—Parasitological collection, Department of Parasitology, School of Hygiene and Public Health, University of the Philippines.

Remarks.—In comparing this fluke with *Stictodora sawakinensis* Looss, 1899, the only member of the genus, we find that our specimen differs from it in the structure of the gonotyl. In Witenberg's account the cone of the gonotyl of *S. sawakinensis* is covered with six to ten longitudinal rows of triangular plates, whereas in our specimen this portion of the gonotyl bears only a circlet of chitinous plates which individually resemble the hooklets of *Tænia.* Moreover, according to Witenberg, there is no ventral sucker either in the genital sac or outside of it in *S. sawakinensis,* whereas longitudinal sections of our specimen show the presence of this organ on the anterior wall of the genital sinus. Therefore, we feel justified in describing our specimen as a new species, which we name *Stictodora manilensis* after the locality where it was first found.

MONORCHOTREMA sp. Plate 3, figs. 1 and 2.

Eight specimens which showed characters of this genus were obtained from the small intestines of five dogs and four from the

small intestine of an adult male Filipino, native of Leyte and residing in Manila at the time of his death. A comparative study of both our human and dog specimens, which we believe represent a single species, with *Monorchotrema taichui* Nishigori, 1924, as described by Witenberg (1929), convinced us that our material represents that species. A short time later we encountered at autopsy in the small intestine of a 60-year-old man, native of Calivo, Capiz, and residing in Manila at the time of his death due to cardiac dilatation, five specimens of what appeared to be a different species of this genus, which we cannot distinguish from *Monorchotrema taihokui* Nishigori, 1924, and which most likely represents that species. Although Faust and Nishigori (1926) succeeded in rearing both trematodes experimentally in man, ours seem to be the first natural human infestations of these heterophyids. The primary intermediate hosts of *M. taichui* and *M. taihokui* in Formosa are *Melania oblique-granosa* (Smith) and *M. reiniana* var. *hidachiens*, respectively; the secondary represented by various species of fish belonging to the families Cyprinidæ, Siluridæ, and Cotilidæ according to the results of feeding experiments conducted by Faust and Nishigori (1926) on man, dog, and cat.

DIORCHITREMA sp. Plate 3, fig. 3.

Forty specimens of this fluke were recovered from the small intestine of three dogs and four from the small intestine of the human host mentioned above in connection with *Monorchotrema taichui*. On comparing our dog and human specimens (which we believe represent a single species) with *Diorchitrema pseudocirrata* Witenberg (1929) we failed to find differences that can be considered specific, or such that might not be produced by variations in methods of fixation or degree of tissue contraction of the flukes. We, therefore, believe that our specimens are identical with *Diorchitrema pseudocirrata* Witenberg, 1929. So far as we are aware this is the first record of human infestation with this trematode. In Palestine the secondary intermediate hosts of *Diorchitrema* are fishes of the genus *Mugil*, which is represented in this country by *talilong*, *banak*, or *balanak*, so presumably human and dog infestation with this fluke here is contracted by eating raw fish belonging to these species and allied forms.

GENERAL REMARKS

The finding of various heterophyid flukes in man and dog in the Philippines marks a new area in the geographic distribution of this group of parasites, although such has been expected on account of our close proximity to China and Japan where both human and animal infestations with members of this group have been frequently observed and reported, and because of the presence here of melanoid snails and various species of fish of the genus *Mugil*, which act as primary and secondary intermediate hosts, respectively, of these parasites wherever they have been found to occur. That these flukes are quite common in Philippine dogs is shown by the fact that of sixty-six autopsies four dogs were found to be infested with *Heterophyes expectans* sp. nov.; five with *Monorchotrema* sp.; three with *Diorchitrema* sp.; and two with *Stictodora manilensis* sp. nov. It seems strange that Wharton (1917) failed to find any member of this group in his autopsies of one hundred eighteen dogs in Manila.

Dr. Marcos Tubangui, of the Bureau of Science, Manila, has had a similar experience. We venture to predict that careful autopsies of our cat population will yield a similar heterophyid parasitic fauna.

It was the finding of these flukes in our dogs that stimulated us to look for similar parasites among the native human population. Our curiosity was amply rewarded by finding not only both *Monorchotrema* and *Diorchitrema* sp., which we encountered previously in dogs, but also a new species, *Heterophyes brevicæca*, even before our tenth autopsy in the Manila City Morgue. The first two flukes were from the small intestine of an adult Filipino, native of Leyte Island, but residing in Manila at the time of his death due to acute cardiac dilatation; the last from the small intestine of an adult male Filipino, native of La Union, northern Luzon, but residing in Manila at the time of his death due to the same cause. Later another *Monorchotrema*, which answers the description of *Monorchotrema taihokui* Nishigori, 1924, was encountered in the small intestine at the autopsy of an old man from the Visayas. It is significant that in the regions from which they came the people are known to have the habit of eating raw fish as do the Chinese and Japanese, a practice that is not looked upon with favor in the Tagalog provinces as far as we know. What we cannot explain

is how these infestations (which judging from the ease with which we encountered them at autopsy seem quite common, at least among our raw-fish-eating population) escaped detection during the last thirty years of active routine fæcal examination in private and Government laboratories, considering the fact that their eggs are larger and even more conspicuous than the cysts of *Entamœba histolytica* and other intestinal Protozoa.

To determine the species of fish that serve as the secondary intermediate hosts of these flukes, feeding experiments, involving puppies and kittens divided into lots each of which is fed from time to time with a species of fish commonly sold in Manila markets, are now in progress.

SUMMARY

Six species of heterophyid trematodes hitherto unknown in the Philippines are reported in this paper. Of these six species, three have never been described before; namely, *Heterophyes expectans* sp. nov. and *Stictodora manilensis* sp. nov. from the small intestines of dogs, and *Heterophyes brevicæca* sp. nov., from the small intestine of a native Filipino. Of the remaining three species, two that were recovered from the small intestine of man and dog cannot be distinguished from *Monorchotrema taichui* Nishigori, 1924, and *Diorchitrema pseudocirrata* Witenberg, 1929, respectively; while the last, which is identical with *Monorchotrema taihokui* Nishigori, 1924, was obtained from man. This is the first time that these last three flukes are reported in man as natural infestations. A critical note on Witenberg's (1929) table of homologous rows, which is intended to show the parallelism in the development of the features in the different subfamilies of Heterophyidæ, is included.

ACKNOWLEDGMENT

We gratefully acknowledge our indebtedness to the Departments of Pharmacology and Physiology and Biochemistry for their courtesy in turning over to us for this investigation the bodies of their used dogs, to the Department of Pathology and Bacteriology for permitting us to obtain material from their autopsies, and to Dr. Walfrido de Leon, head of the Department of Sanitary Bacteriology and Immunology, for the microphotography.

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ILLUSTRATIONS

[Drawings by Mr V. V. Marasigan.]

ABBREVIATIONS

os, Oral suckers
ac, Acetabulum
gs, Genital sac.
gth, Gonotyl.
vs, Vesicula seminalis.
rs, Receptaculum seminis
oes, Œsophagus.
ov, Ovary.
t, Testes.
cp, Cirrus pouch
ut, Uterus.
vag, Vagina.
vg, Vitelline glands.
exb, Excretory bladder.
ed, Ejaculatory duct.
pg, Prostatic glands.
exp, Expulsor.

PLATE 1

FIG. 1. *Heterophyes expectans* sp. nov., entire worm, ventral view.
2. *Heterophyes brevicæca* sp. nov., entire worm, ventral view.

PLATE 2

FIG. 1. *Stictodora manilensis* sp. nov., entire worm, ventral view.
2. *Stictodora manilensis* sp. nov., showing transverse section, the tip of the gonotyl with the single circlet of spines.
3. *Stictodora manilensis* sp. nov., transverse section, showing the rudimentary ventral sucker. Figs. 2 and 3 are from the same specimen.

PLATE 3

FIG. 1. *Monorchotrema* sp., entire worm, ventral view, indistinguishable from *M. taichui* Nishigori, 1924.
2. *Monorchotrema* sp., entire worm, ventral view, indistinguishable from *M. taihokui* Nishigori, 1924.
3. *Diorchitrema* sp., entire worm, ventral view, indistinguishable from *D. pseudocirrata* Witenberg, 1929.

PLATE 4

FIG. 1. *Heterophyes brevicæca* sp. nov., entire worm.
2. *Heterophyes expectans* sp. nov., anterior end not showing.
3. *Heterophyes expectans* sp. nov., the acetabulo-genital area showing the rodlets of the gonotyl.
4. *Stictodora manilensis* sp. nov., anterior end not showing.

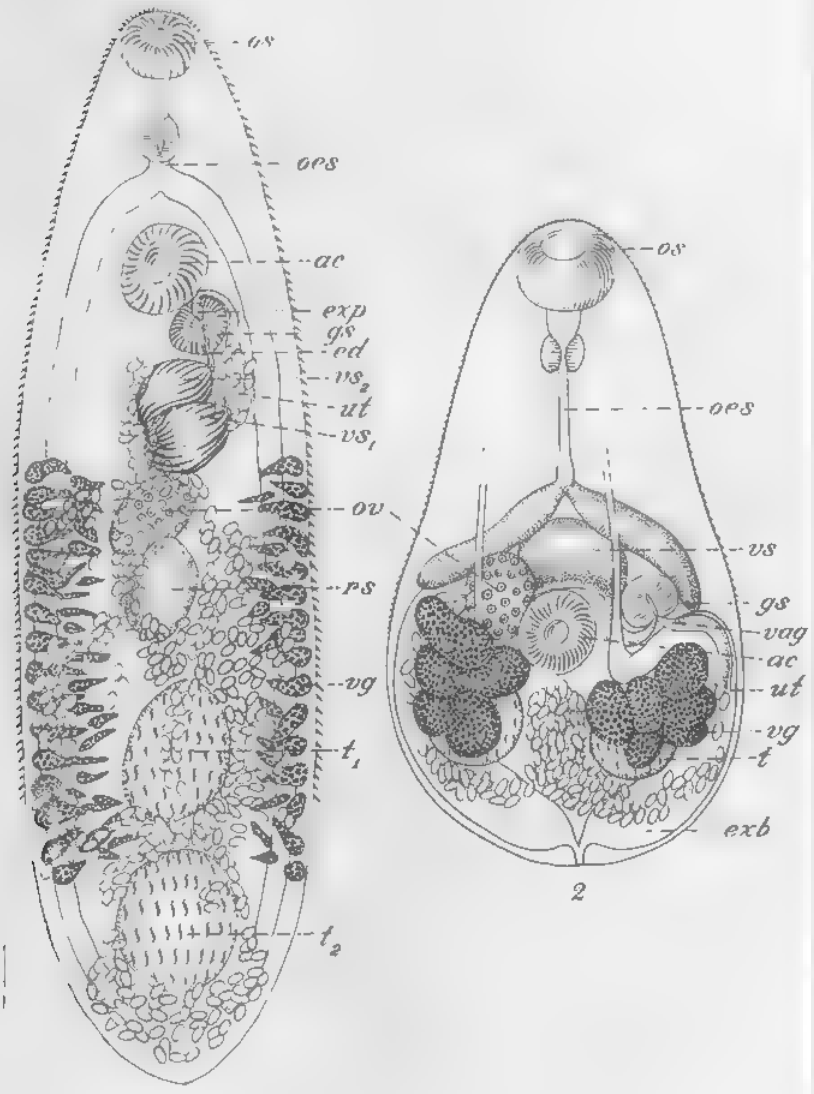
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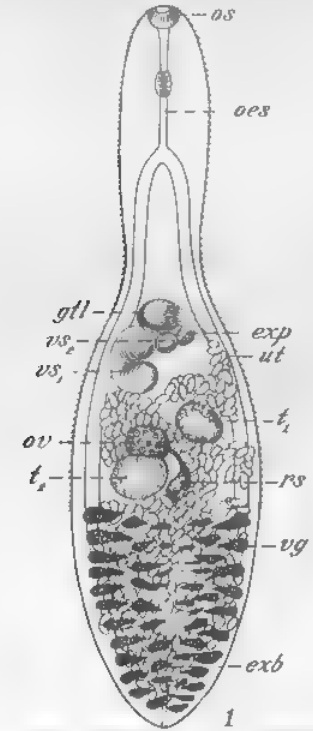
PLATE 1.



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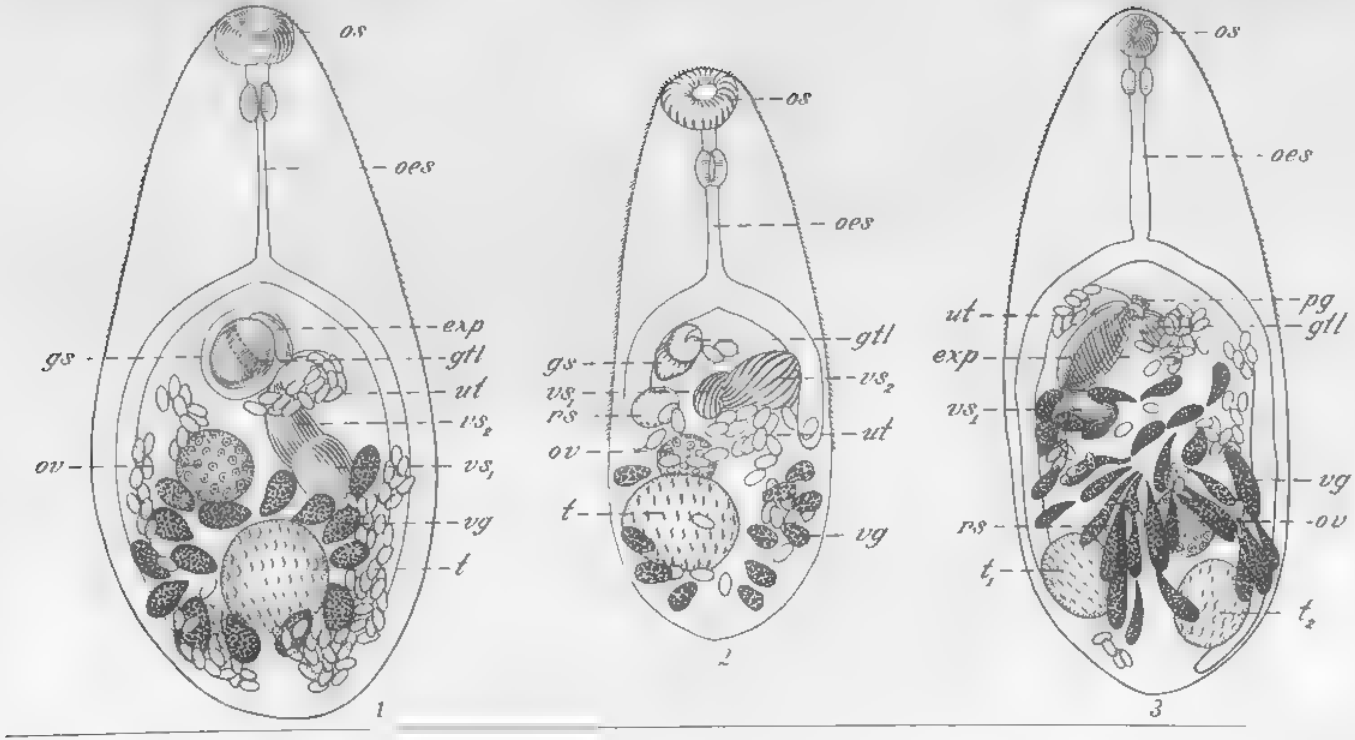
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PLATE 3.

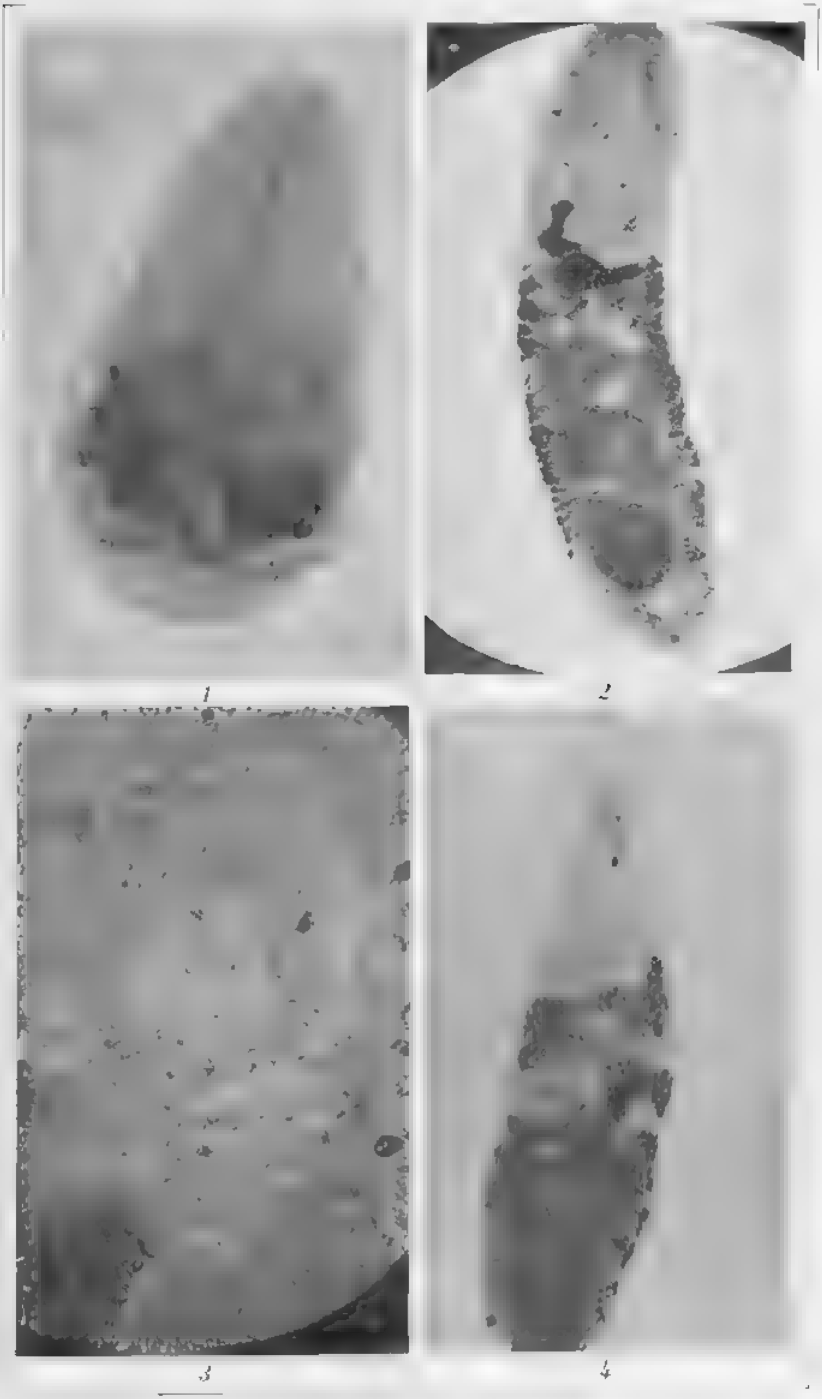

PLATE 4.

RESULTS OF THE BACTERIOLOGICAL EXAMINATION OF ICE DROPS MANUFACTURED IN MANILA

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THREE PLATES

Of the various kinds of frozen preparations used as refreshment food in the Philippines, there is a product, the "ice drop," which, because of its low price when compared with that of ice cream, is in great demand by the public in general. The manufacture of ice drops requires no special or technical knowledge. In fact it is so simple that in no time several factories have been established in Manila and in many provinces.

Since ice drops are classified as foods, their preparation must conform to certain sanitary regulations prescribed by the Bureau of Health. For this reason the factories are subjected to rigid inspections and the products are frequently submitted to the Bureau of Science for bacteriologic examination. The results of the examinations are recorded in this paper, and recommendations are made on how the products may be improved from the bacteriologic standpoint.

PREPARATION OF ICE DROPS

Materials used.—Ice drops are frozen mixtures containing sugar, cereals or root products, fresh or preserved fruits, water, and sometimes milk. Artificially colored and flavored stuffs are often used in place of fruits.

The flavoring substances most often used are extracts of lemon, strawberry, orange, vanilla, pineapple, and banana. The local fresh fruits and cereals commonly employed are listed in Table 1.

TABLE 1.—*Local and botanical names of the common local fresh fruits, root products, and cereals used for making ice drops.*

Ube. *Dioscorea alata* Linn.
Macapuno. *Cocos nucifera* Linn.
Buco. *Cocos nucifera* Linn.
Nangka. *Artocarpus integra* (Thunb.) Merr.
Piña. *Ananas comosus* (Linn.) Merr.
Melon. *Cucumis melo* Linn.
Avocado. *Persea americana* Mill.
Papaya. *Carica papaya* Linn.
Mango. *Mangifera indica* Linn.
Atis. *Anona squamosa* Linn.
Pinipig (toasted rice). *Oriza sativa* Linn.
Lechias. *Litchi chinensis* Sonn.
Corn. *Zea mays* Linn.
Banana. *Musa sapientum* Linn.

In order to give ice drops a certain consistency, a thin solution of "gaogao" (starch prepared from the roots of *Manihot utilissima* Pohl) is frequently added to the mixture. An ice drop is named after the principal substance used in its preparation, and its price depends upon the quality of its ingredients.

Freezing apparatus.—The freezing apparatus is an ice box, at the bottom of which are coiled brass pipes submerged in a saturated solution of calcium chloride (Plate 1). The cooling is done by running into the brass pipes ethyl chloride supplied from a tank by a motor. In order to produce a uniform cooling, the saturated solution of calcium chloride is slowly stirred by a paddle moved by an electric motor. A large factory has at least three or four of these freezers and one refrigerating ice-drop cabinet (Plate 2).

Method of freezing.—The mixture to be frozen is placed in molds and then a wooden or bamboo stick previously washed in boiling water is introduced into each mold (Plate 3, fig. 1). The stick serves as a holder for the frozen product. As shown in Plate 1, the filled molds are placed on a tray provided with circular holes. Each tray can hold as many as sixty-four molds and one ice box can accommodate two trays at a time. The trays are so placed inside the ice box that the molds are submerged to about four-fifths of their length in the solution of calcium chloride. The average time required to freeze a mixture is from fifteen to twenty minutes. When frozen the molds are taken out one by one from the ice box and each is dipped quickly in

warm water in order to facilitate the removal of the frozen product. The ice drop (Plate 3, fig. 2) is then removed from its mold by means of the stick holder, wrapped in glazed paper, and stored in the cool ice-drop cabinet.

MATERIALS AND METHODS

The samples of ice drops examined were collected by sanitary inspectors of the Bureau of Health in sterilized bottles and were received in the laboratory in the melted state. Between January, 1933, and January, 1934, 1,210 samples were examined, of which 897 were obtained directly from factories and 313 were collected from peddlers.

The samples were diluted with sterile distilled water in the proportion of 1 part of ice drop to 10 or 100 parts of the mixture, depending upon the consistency of the sample. For the bacterial count 0.1 cubic centimeter of the mixture was plated in ordinary meat-extract agar and incubated at 37° C. for forty-eight hours. For the isolation of *Bacillus coli* Durham's and Smith's fermentation tubes containing lactose broth were inoculated with 1 and 10 cubic centimeters, respectively, of the mixture.

RESULTS OF EXAMINATIONS

The results of the bacterial counts are summarized in Table 2. In this table the standard of not more than 100,000 bacteria

TABLE 2.—*Results of bacterial examination of 1,210 ice drops.*

Colonies per cc.	Samples collected from factories.		Samples collected from peddlers.		Total samples.	
		Per cent.		*Per cent.*		*Per cent*
0–100,000	269	29.99	156	49.84	425	35 12
100,001 +	628	70.01	157	50.16	785	64.88
Total	897	100.00	313	100.00	1,210	100 00

per cubic centimeter of sample prescribed by the Bureau of Health (Food and Drugs Act) is used to classify the results of our examinations. Of the 897 samples collected directly from factories, 269, or 29.99 per cent, had counts of from 0 to 100,000 colonies per cubic centimeter, and 628, or 70.01 per cent, had more than 100,000 colonies per cubic centimeter each. Of the 313 samples collected from peddlers, 156, or 49.84 per cent, had

counts not exceeding 100,000 colonies per cubic centimeter, while 157, or 50.16 per cent, had more than 100,000 colonies per cubic centimeter. Considering the total number of samples examined, 425, or 35.12 per cent, met the standard requirement of the Bureau of Health, while 785 samples, or 64.88 per cent, had an excessive number of bacteria.[1]

The number of samples that were positive to the presumptive test was 867, or 71.6 per cent. From none of these samples, however, was *Bacillus coli* isolated, the inoculated eosin-methylene-blue-agar plates showing mostly organisms of the *aerogenes* group. It has been shown by Schöbl and Ramirez (1925) and Schöbl and Rosario-Ramirez (1931) that this group of bacteria is very widely distributed in nature. Quoting from Schöbl and Ramirez, "The presumptive test is used as a preliminary test and as an indication of whether or not a further search for *B. coli* should be attempted. A positive presumptive test indicates that some sugar fermenters (lactose) are present. *Bacillus coli* is only one of the many bacteria that ferment sugars. Consequently, not much significance should be attributed to this test, particularly when the colony count is low and the bacteria responsible for the fermentation are of the *aerogenes* group. It has been demonstrated that this group of bacteria in the Tropics is ubiquitous. They are present in places far remote from any possible fæcal pollution and this group of bacteria includes forms that are present in soil and vegetation and which cannot be distinguished either by cultural or serologic methods from the same species encountered in the fæces."

In order to find the probable reasons for the large percentage of samples that failed to meet the bacteriological standard prescribed by the Bureau of Health, an inquiry was made into the bacterial counts of the different ingredients used in the preparation of ice drops. It was found, as shown in Table 3, that the

[1] As noted elsewhere, the ice drops were received in the laboratory in the melted state and the examinations were usually made after two hours from the time the samples were collected by sanitary inspectors. In order to determine if any appreciable increase in the original colony count of a sample takes place during this time interval, arrangements were made with Dr. Paulino K. Navarro, of the Bureau of Health, to send us products packed in dry ice. These were received intact in the laboratory and were examined at different intervals of time. The results showed that up to two hours after the collection of the samples, the differences in the colony counts were negligible.

TABLE 3.—*The bacterial content of some of the extracts and colored foodstuffs used in the preparation of ice drops.*

Materials examined and manufacturers.	Colonies per mg.		Presumptive test.
	Immediate plating.	After standing for 48 hrs.	
I. G. Farbenindustrie Aktiengesellschaft, Frankfurt am Main, Germany.			
(a) Egg yellow (powder)	60	80	Negative.
(b) Violet 237 (powder)	30	60	Do.
(c) Red (powder)	75	45	Do.
(d) Lemon yellow (powder)	60	30	Do.
II. Joseph Chemical Laboratory, 674 Evangelista, Quiapo, Manila.			
(a) Egg yellow (powder)	1,320	291,900	Do.
(b) Red (powder)	165	150	Do.
	Colonies per cc of a dilution of 1 to 10 cc.		
(c) Banana extract (liquid)	45	30	Do.
(d) Orange extract (liquid)	30	90	Do.
Boiled water from one ice-drop factory (undiluted)	50	26,330	Do.
III. Watsonal Drug Co., Manila.			
(a) Raspberry extract (liquid)	0	240	Do.

high bacterial content of the samples could not be attributed to the use of fruit extracts and artificially colored stuffs. The suspicion falls on the use of fresh fruits, cereals, and coconut milk, for in going over the list of ice drops of known composition it was noted that the large majority of the samples which had these materials as the principal ingredients had very high bacterial counts.

RECOMMENDATIONS

Manufacturers of ice drops could improve the quality of their products from the bacteriological standpoint by observing simple precautions in addition to the rules and regulations given in the Bureau of Health Administrative Orders No. 70 and 93 and in Administrative Decision No. 228, adopted August 15, 1934, by the Board of Food Inspections. These precautions are the following: (*a*) Only water that has been recently boiled should be used for diluting the ingredients; (*b*) the hands of those engaged in the preparation of ice drops should be thoroughly cleansed; and (*c*) in order to maintain as much as possible the original bacterial content of a mixture, the latter should be frozen within three hours after its preparation.

SUMMARY AND CONCLUSIONS

During the period from January, 1933, to January, 1934, 1,210 samples of ice drops were received at the Bureau of Science for bacteriological examination. Of these, 785, or 64.8 per cent, had bacterial counts exceeding the standard of 100,000 colonies per cubic centimeter recommended in the Food and Drugs Act. In the routine manufacture of ice drops, as it is now being done in most of the factories, it cannot be expected that the bacterial counts of these products will always conform to the prescribed standard, but our observations indicate that such a standard is within reasonable limits and that it should therefore be maintained.

Of the total number of samples examined, 867, or 71.6 per cent, gave positive presumptive tests, but none was positive for *Bacillus coli*. The wide distribution in nature of sugar-fermenting bacteria other than *Bacillus coli* is probably responsible for the large number of samples giving positive presumptive tests. On the other hand, the large percentage of samples with high bacterial counts is due either to faulty handling of the products or to the use of badly contaminated ingredients. Recommendations are given in order to help the manufacturers of ice drops to keep the bacterial counts of their products at a minimum.

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ILLUSTRATIONS

PLATE 1.

PLATE 2.

THE TREATMENT OF HUMAN BERIBERI WITH CRYSTALLINE ANTINEURITIC VITAMIN

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Of the Bureau of Science, Manila

and

FROILAN EUBANAS

Of the Bureau of Health, Manila

Beriberi occurs principally in countries of the Far East; such as, the Philippines, Japan, China, Siam, India, Dutch East Indies, and the Federated Malay States. In these countries the diet of the masses consists largely of rice.

Beriberi is not confined entirely to countries of rice-eating populations, because researches on nutrition have shown that it is a deficiency disease, which may occur wherever the diet of people is lacking in vitamin B_1.

Studies on the etiology and treatment of adult and infantile beriberi in the Philippines have been made by Herzog,(1) Chamberlain et al.,(2) Albert,(3) L. Guerrero,(4) Andrews,(5) Williams and Saleeby,(6) M. Guerrero,(7) Saleeby,(8) and Chamberlain.(9)

Beriberi has been classified into two well-marked types, the dry and the wet, according to their symptoms and manifestations. The dry type is characterized clinically by great wasting and anæsthesia of the skin, which finally results in paralysis of the limbs. The wet type manifests excessive œdema, which may affect the trunk, limbs, and extremities. In cases with excessive œdema the heart usually becomes enlarged, and heart failure may result.

Various theories have been advanced as to the causes of beriberi, but the concensus of most authorities on nutrition is that beriberi is a deficiency disease and is caused by a lack of vitamin B_1.

Andrews(5) concluded that the high death rate of infants in the Philippines in 1912 was due primarily to the quality of the mother's milk. He recommended, as a prophylactic measure, the use of unpolished rice for pregnant women of the poorer

classes. Albert(3) classified infantile beriberi in three types; the cardialgic, aphonic, and pseudomeningitic. As a result of his studies on infantile beriberi based on 514 cases he concluded that infantile beriberi is a true deficiency disease. Other clinicians and investigators, like L. Guerrero,(4) Chamberlain,(9) Williams and Saleeby,(6) and M. Guerrero,(7) have used to a considerable extent the extract of rice polishings in the treatment of infantile beriberi. The extract proved to be a beneficial and efficient prophylaxis. Saleeby(8) treated human beriberi with marked results by the use of autolyzed yeast extract.

According to the information we have received from Dr. E. M. Nelson, Protein and Nutrition Division, Bureau of Chemistry and Soils, Washington, D. C., Dr. B. C. Jansen, of Amsterdam, has expressed the opinion that man is probably fully protected from beriberi when he consumes food that will provide 200 international units of antineuritic vitamin per day. In the standardization(10) of the Bureau of Science tikitiki extract, we found that one teaspoonful gives approximately 80 international units of vitamin B_1. The Bureau of Science tikitiki extract(11) is a concentrated aqueous extract of rice polishings (1 cc of extract corresponds to 14.5 g rice bran). It is used in large quantities by the puericulture centers, Bureau of Health, to combat or eradicate infantile beriberi in the Philippine Islands.

According to Table 1, the mortality from beriberi in the Philippines for the ten years 1924–1933 was 187,808, and about

TABLE 1.—*Deaths from beriberi in the Philippine Islands for the years 1924–1933.*

Year.	Manila (residents only.)			Provinces, including transients in Manila.			Total.		
	Infants.	Adults.	Total.	Infants.	Adults.	Total.	Infants.	Adults.	Total.
1924	577	23	600	12 612	5,795	18,407	13,189	5,818	19,007
1925	558	29	587	12,936	5,019	17,955	13,494	5,048	18,542
1926	495	31	526	13,532	5,151	18,683	14,027	5,182	19,209
1927	258	30	288	12,317	4,470	16,787	12,575	4,500	17,075
1928	340	28	368	11,951	4,464	16,415	12,291	4,492	16,783
1929	519	33	552	14,622	5,051	19,673	15,141	5,084	20,225
1930	286	40	326	15,199	5,049	21,248	16,485	5,089	21,574
1931	173	23	196	14,845	4,497	19,342	15,018	4,520	19,538
1932	200	22	222	13 102	3,849	16,951	13,302	3,871	17,173
1933	196	10	206	14,524	3,952	18,476	14,720	3,962	18,682
Total.	3,602	269	3,871	136,640	47,297	183,937	140 242	47,566	187,808

74.67 per cent of those that die of beriberi are infants. For this period the average yearly death rate for a population of 100,000 (infants and adults) was 156.75. The mortality from beriberi in the City of Manila has been reduced very appreciably from 600 in 1924 to 206 in 1933. This significant decrease is probably due to the various health activities and the extensive use of tikitiki extract in Manila.

Since the first publication on the existence of an antineuritic vitamin many attempts have been made to prepare concentrated products and to isolate this vitamin from various materials, such as rice polishings, yeast, wheat germs, and mongo beans (*Phaseolus aureus*). Some investigators claimed to have produced or isolated an antineuritic vitamin in pure crystalline form possessing the therapeutic properties of vitamin B_1. Prominent among these may be mentioned Seidell,(12) Jansen and Donath,(13) Levene,(14) Kinnersley et al.,(15) Odake,(16) Cowgill,(17) and Seidell and Smith.(18) In recent years Williams and coworkers(19) published several papers and reported their method for preparing larger yields of the crystalline antineuritic vitamin.

The material employed in this preliminary report was the crystalline vitamin B_1 hydrochloride prepared from rice polishings by Williams and coworkers.(19)

Dr. R. R. Williams kindly sent to the Bureau of Science 100 milligrams of the crystalline vitamin B_1 hydrochloride to be tested on human beriberi. A sterilized solution of 1 milligram per cubic centimeter was prepared in vials with rubber cap. The solution was given by intramuscular injection when the patients came to the clinic.

Ten patients were treated in the clinic of the Walled City puericulture center, and two others who were patients in the Philippine General Hospital. The clinic patients were instructed to follow their regular diet, and not to eat rice polishings, mongo, (*Phaseolus aureus*), or other foodstuffs rich in vitamin B_1. The results of treating human beriberi with this preparation are given in the records of the following twelve cases.

CASE 1

Josefa Cañares, female, married, living at 54 Alvarado Street, interior 18, Tondo, Manila, para 10, complained for about five months of numbness in both legs and tips of the fingers, and also around the mouth. The numbness which began in the legs and toes, became worse during the last five months. In the beginning she felt pain in the calves and some peculiar pains around

the epigastric region. There was no vomiting. She had chest oppression on walking for some distance. Physically well developed and fairly nourished. Conjunctivæ were pale, and lung cavities were clear. Heart showed accentuation of the second pulmonic sound, and no evidence of increased dullness. Liver and spleen were negative. Legs showed no œdema, and skin was clean and dry. Knee jerk was sluggish.

March 17, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 19, 1934.—One cc injected into the left arm. Patient did not feel anything after the first injection.

March 20, 1934.—One cc injected into the right arm. Patient did not complain of anything unusual since the first injection.

March 27, 1934.—One cc injected into the left arm. Patient felt better, appetite was good, and the numbness was diminishing.

April 5, 1934.—One cc injected into the right arm. Patient felt much improved. She said that she could wear her slippers, which she could not do before. The numbness of the extremities and toes was diminishing. Calf pains have disappeared. Appetite was better, and her color improved. Knee jerk became stronger than in the first examination.

Patient did not come back for further treatment.

CASE 2

Gregoria Lim, 32 years, female, married, para 2, residing at Farola, Manila, complained of numbness at the tips of fingers, around the mouth, and at right thigh; also sensation of thickness and heaviness at the epigastric region. At times she felt a prickling sensation all over the body (not due to prickly heat). She experienced numbness in her right thigh for about six months and she was pregnant. The numbness at the tips of her fingers occurred right after the last delivery and lasted about 1.5 months. She was physically well-developed and fairly nourished; there was a cataract on the left eye. The right eye had been operated on previously. She had some dental caries. Heart and lungs were negative. Spleen and liver were negative. The knee reflexes were exaggerated. Skin was clean and dry.

March 19, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 20, 1934.—One cc injected into the left arm. Patient did not feel anything.

March 21, 1934.—One cc injected into the right arm. The numbness at the fingers and around the mouth was diminishing.

March 22, 1934.—One cc injected into the left arm. There was slight pain at the site of injection.

March 28, 1934.—Patient was injected with 1 cc into the right arm. Patient said that the numbness in finger tips and mouth disappeared. The prickling sensation all over the body also disappeared. She still had the numbness at the right thigh though not so pronounced as before. Knee jerk was not very much exaggerated. She felt fully recovered from her troublesome complaints except the slight numbness in right thigh.

CASE 3

Macaria Garcia, 35 years, female, married, residing at 912 interior San Marcelino Street, Manila, para 4 (all living) complained for about a month of numbness in the legs and feet and also of numbness and a tingling sensation in the fingers. In her second delivery she had similar symptoms but they were not so bad as at the present time. At times she felt chest oppressions. She was physically well developed and fairly nourished. The chest and lungs were clear but she was anæmic with face slightly puffy. Heart was apparently negative. Liver and spleen were negative. The knee reflex was absent. There was flabbiness in the muscles of the legs with signs of muscular atrophy. The skin was dry and fairly clean.

March 20, 1934.—One cc of vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 22, 1934.—One cc injected into the left arm. Patient made no complaints.

March 23, 1934.—One cc injected into the right arm. Patient did not feel any sign of relief. She appeared brighter, however, and face was not puffy in appearance. Knee jerk was absent.

March 24, 1934.—One cc injected into the left arm. Patient had no other signs of improvement.

From March 25 the patient did not report to the clinic and hence further observations could not be made.

CASE 4

Nicolasa Carumba, 37 years, female, married, para 7 (3 living), residing at 1019 Georgia Street, Malate, Manila, complained for about three months of numbness in legs. At times she felt some formications at thighs, and had chest oppressions. She was physically a well-developed and fairly nourished individual. Chest, heart, and lungs were negative. Liver and spleen were negative. Knee reflexes were slightly exaggerated in the right leg though less so in the left. The skin was clean and dry.

March 21, 1934.—One cc of vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 22, 1934.—One cc injected into the left arm. Patient felt nothing unusual.

March 26, 1934.—One cc injected into the right arm. Chest oppression and formications at thighs disappeared. She felt only numbness in the legs although this had slightly diminished. Reflexes were the same as at the first examination.

March 27, 1934.—One cc injected into the left arm. She felt very much improved. Appetite was good, and she could sleep better than on previous nights. Numbness in the legs was still present.

March 28, 1934.—One cc injected into the right arm.

From March 29 the patient did not report to the clinic and hence further observations could not be made.

CASE 5

Julia Ramelio, 21 years, female, married, residing at 36 Alfredo Street, Sampaloc, Manila, para 1, complained for 1.5 months of numbness in both legs and feet, around the mouth, and of a feeling like a constricting band around the epigastric region. She had at first chilliness and fever for a day, and subsequently numbness in both legs. When she was still pregnant she had frequent attacks of pain in calves. The symptoms gradually became worse until she felt numbness around her mouth. She was physically well developed, fairly nourished, anæmic, but a walking patient. Head and neck were negative. Chest and lungs were clear. Heart showed accentuation of the second pulmonic sound. No murmurs were heard in other valvular areas. Spleen and liver were negative. Knee reflexes were absent. There was slight œdema in the right leg.

March 23, 1934.—One cc of vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 24, 1934.—One cc injected into the left arm. Patient did not have any complaints.

March 26, 1934.—One cc injected into the right arm.

March 27, 1934.—One cc injected into the left arm.

March 31, 1934.—One cc injected into the right arm. Patient complained only of slight numbness in the legs and feet. She had no numbness at the mouth; occasionally felt constriction in epigastric region. She felt stronger and had a better appetite. Œdema disappeared.

From March 31, 1934, she did not report to the clinic for further observation.

CASE 6

Maria Fernandez, 30 years, female, mother of 5 children, 3 of whom died (2 with symptoms of beriberi). Of the living children, 1 was 9 years old and the other was 6. The patient was actually in the ninth month of pregnancy. She was complaining of numbness in the tips of the fingers, sensation of formications at the lower extremities (calves and feet), and thickness around the mouth. She also complained of weakness and tenderness of the muscles of legs and frequent palpitation. The symptoms were felt by the patient since February, 1934. She was physically a well-developed and fairly nourished individual. Head and neck were negative. Lungs were clear. The heart showed no signs of abnormality. Liver and spleen were negative. There was marked diminution of the knee reflex. There was slight œdema in the malleoli region.

March 24, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 25, 1934.—One cc injected into the left arm.

March 27, 1934.—One cc injected into the right arm. Tenderness in the muscles of the legs was disappearing. She felt stronger and better.

March 28, 1934.—One cc injected into the left arm. Œdema at the malleoli disappeared. Patient felt much stronger and appetite was good. Knee jerk was still sluggish.

March 31, 1934.—One cc injected into the right arm. The numbness in the lower extremities was improving. Knee reflexes were slow. The tenderness in muscles of legs improved.

April 3, 1934.—One cc injected into the right arm.

April 4, 1934.—One cc injected into the left arm. She had still some numbness in the fingers. She ate well and felt stronger and very much improved.

April 5, 1934.—One cc injected into the right arm.

April 6, 1934.—Patient did not report again for further treatment.

CASE 7

Remedios Francisco de Flores, 24 years old, married, residing at 35 Plaza McKinley, Walled City, Manila, complained of numbness of the upper and lower extremities. Her first child suffered from a disease diagnosed by a physician as chronic infantile beriberi. The infant recovered. The actual symptoms were felt by the patient fifteen days after delivery. She felt weakness and tenderness in the muscles of the extremities. She also complained of palpitation and an uneasy sensation in the abdomen. She was physically well developed. Lungs and heart were apparently negative. Liver and spleen were negative. Patellar reflex was very much diminished.

March 24, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm. There were no after-effects.

March 26, 1934.—One cc injected into the left arm.

April 3, 1934.—One cc injected into the right arm. Patient felt a slight improvement.

April 4, 1934.—One cc injected into the left arm. Patient felt better and claimed improvement since first injection.

April 5, 1934.—Patient did not report again for further treatment.

CASE 8

Isabel To, 23 years, female, married, residing at 191 Palomar, Tondo, Manila, para 4 (1 having died of infantile beriberi, or "taon", according to her physician). The remaining 3 were well and healthy. She complained of numbness in the feet and legs, formication of fingers, chest oppression, and fatigued easily on walking. Duration of these complaints was two months. She also felt a thickening sensation around her mouth and about the face. Every morning she felt pain in the calves and feet. She was physically well developed and a walking patient. Chest and lungs were clear. Heart showed slight accentuation of second pulmonic sound. Liver and spleen were negative. Knee jerks were absent. Skin was clean and dry.

March 26, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 27, 1934.—One cc injected into the left arm.

March 28, 1934.—One cc injected into the right arm. She felt that the numbness was much diminished and the formications at fingers were disappearing. She did not complain much of chest oppression, and she could walk for longer distance without easily becoming fatigued.

April 2, 1934.—One cc injected into the left arm. She felt better than the last observation.

From April 3, the patient did not report to the clinic for further observation.

CASE 9

Emiliana B. de Julio, 34 years, female, married, residing at 727 Sanchez Street, Binondo, Manila, para 8; 3 children died of infantile beriberi according to her physician. She was actually in the eighth month of pregnancy. She complained of numbness in the tips of the fingers and toes, and also had dull pains in the loins for about one month. She was a physically well-developed and well-nourished individual. Head and neck were negative. Chest, heart, and lungs were negative. Liver and spleen were negative. The knee jerk was normal, and the skin was clean and dry.

March 26, 1934.—One cc vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm.

March 27, 1934.—One cc injected into the left arm. The patient was better, and the numbness at tips of fingers diminished.

March 28, 1934.—One cc injected into the right arm. Patient felt better.

April 2, 1934.—One cc injected into the left arm. The numbness disappeared according to the patient. She felt better and had a good appetite and could sleep well.

April 3, 1934.—One cc injected into the right arm.

April 4, 1934.—One cc injected into the left arm.

April 5, 1934.—One cc injected into the right arm. The complaint of numbness practically disappeared.

April 6, 1934.—Patient did not report again to the clinic for further treatment.

CASE 10

Juana de la Cruz, 29 years of age, was a widow. Her illness, which began six months previously, was manifested by the gradual loss of body weight and general debility. Upon consultation she complained of pain and oppression of the chest accompanied by difficult breathing. There was a sensation of fullness and dull pain of the hypogastrium. There was numbness of both the upper and lower extremities, and numbness and formication of both lips. Tachycardia was present, and the patient was nervous. She complained of insomnia and loss of appetite. Hyperreflex of the knee jerk was observed.

April 2, 1934.—One cc of vitamin B_1 solution containing 1 mg was injected intramuscularly into the right arm. There was no improvement.

April 4, 1934.—One cc injected into the left arm. There was no improvement.

April 6, 1934.—One cc injected into the right arm. The patient showed sign of improvement, by the slight disappearance of numbness of the upper and lower extremities. She now had fair sleep and appetite.

April 9, 1934.—One cc injected into the left arm. She had marked improvement with the disappearance of chest oppression and hypogastric dullness.

April 11, 1934.—The patient did not report again for further observation.

CASE 11

Carmelita Yumol, female, 2 months old, entirely breastfed, was admitted to the pay section of Philippine General Hospital on June 29, 1934, in a very serious condition, with complaints from the parents of persistent crying, difficult breathing, and cyanosis of face. Child had not received any tikitiki extract since birth. The present illness started early in the morning and she was brought to the hospital at about noon. Physical findings revealed cyanosis of lips, persistent crying, and a rather muffled heart sound. Child semistuporous.

Treatment.—Five-tenths cc of vitamin B_1 solution containing 0.5 mg was given by intramuscular injection. Tikitiki extract (5 cc every 15 minutes) was given and also a hypodermic injection of 50 cc isotonic glucose solution. About eight hours after admission, the baby showed marked improvement and recovered rapidly soon after.

Diagnosis.—Cardiac infantile beriberi. Discharged July 3, 1934.

CASE 12

Antonio Banigued, male, 7 months old, entirely breastfed, was admitted on May 29, 1934, to charity ward, Philippine General Hospital. Present illness began three days previously as vomiting after nursing, soon accompanied by gradual weakening of voice and restlessness. On the third day child developed tympanism, difficult breathing, and staring of eyes. This attack was repeated several times in the morning of admission. Physical findings—accentuated second pulmonic sound and exaggerated knee jerk.

Treatment.—One cc of vitamin B_1 solution containing 1 mg was given twice by hypodermic injection. On the next day the child appeared apparently normal. An X-ray examination of the heart showed no enlargement.

DISCUSSION AND SUMMARY

Crystalline antineuritic vitamin was used in treating cases of human beriberi, both adult and infantile. It was given by intramuscular injection to ten adults and two infants.

The treatments as described in cases 1, 2, 5, 7, 8, 9, and 10 showed that the crystalline antineuritic vitamin gave very promising indications of curing human beriberi.

Cases 3 and 4 showed good indications of being cured with the exception that the numbness in the legs was still present when the patients reported at the clinic for the last time. However, each patient was given another injection, but none came back for further observation.

In case 6 the patient was relieved of her complaints with the exception of some numbness at her fingers. She was given another injection and did not report again at the clinic for further observation.

Cases 11 and 12 were diagnosed at first as having infantile beriberi. The cure could not be attributed mainly to the administration of the crystalline antineuritic vitamin since the patients were given tikitiki extract.

ACKNOWLEDGMENT

The authors wish to thank Dr. R. R. Williams and coworkers, of Columbia University, New York City, for the valuable sample of antineuritic vitamin used in these tests, and Dr. Moises Abad for his kindness in administering injections to two patients in the pediatric ward of the Philippine General Hospital. They are also indebted to Dr. José Guidote, section of vital statistics, Bureau of Health, Manila, for data on the mortality from beriberi in the Philippine Islands.

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THE NITROGEN DISTRIBUTION AND CARBOHYDRATE PARTITION IN PHILIPPINE RICE BRAN[1]

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Due to its varied uses and highly nutritive properties Philippine rice bran, locally known as "tikitiki" or "darak," has been the subject of study by several investigators.(1 to 5) Considering, therefore, its importance as a foodstuff, any further investigation relative to its properties and chemical composition should be of value.

This paper gives the results of a study of the nitrogenous and carbohydrate constituents of Philippine rice bran. A preliminary notice of our study of the nitrogen distribution in rice bran was published recently.(1)

The rice bran used in this investigation was obtained directly from a rice mill on Azcarraga Street, Manila. It was a high-grade bran that contained no rice hulls, mold spores, insects, or other foreign admixture. In order to avoid any appreciable deterioration of the bran, due to storage, portions of the fresh bran were taken immediately after milling for the various analytical determinations.

TABLE 1.—*Composition of Philippine rice bran.*

Constituent.	Rice bran.	
	Air dried.	Moisture free.
	Per cent.	*Per cent.*
Moisture	11.65	
Fat (ether extract)	19 81	22.42
Protein (2.264 per cent nitrogen)	12 60	14 15
Ash	10.41	11.78
Crude fiber	6.32	7.15
Carbohydrates (by difference)	39.31	44.50
Total	100 00	100.00

The composition of the bran (Table 1) was determined in the usual manner.(6) The Gunning method, modified to include the

[1] Read before the Third Philippine Science Convention, Manila, February 28, 1935.

nitrogen of nitrates,(7) was followed for the total nitrogen determination.

NITROGEN DISTRIBUTION

Experimental procedure.—The following methods were used for determining the different kinds of nitrogen.

Nonprotein nitrogen.—A quantity (15 grams) of bran was repeatedly extracted with ammonia-free water. The clear aqueous filtrate was boiled with a few drops of acetic acid, cooled, filtered, and made up to a definite volume. Two aliquot portions of this protein-free aqueous extract were taken for the duplicate nitrogen determinations according to the method recommended by Pucher, Leavenworth, and Vickery.(8)

The remainder of the extract was used for the nitrogen distribution of the nonprotein nitrogen.

Data on the distribution of the nonprotein nitrogen into acid amide, humin, basic, and nonbasic (Table 2) were obtained in accordance with the method of Hausmann as modified by Jodidi.(9)

Protein nitrogen.—This was determined directly from the rice bran using Stutzer's method.(6)

The results of the protein-nitrogen distribution (Table 2) were calculated by subtracting the percentages of the various kinds of nonprotein nitrogen (Table 2) from the corresponding percentages of the nitrogen products obtained from the bran after acid hydrolysis (Table 3).

Water-soluble nitrogen.—A sample (10 grams) of bran was placed in a bottle with 500 cubic centimeters of distilled water and shaken in a machine for two hours. The clear supernatant liquid was decanted from the sediment. This treatment was repeated twice and the combined aqueous liquids filtered. The residue was then placed on the filter used for the decanted liquid and washed thoroughly. The filtered aqueous extract was diluted to a definite volume. Two aliquot portions of the extract were taken for duplicate nitrogen determinations (method of Pucher, Leavenworth, and Vickery).

Free amino-acid nitrogen.—From the remaining portion of the aqueous extract of bran prepared as above described, the amino-acid nitrogen was determined following Van Slyke's method.(10)

The nitrogen partition in the bran after acid hydrolysis (Table 3) was carried out according to Jodidi and Moulton's procedure.(11)

Results.—Data on the various kinds of nitrogen contained in Philippine rice bran are given in Tables 2 and 3.

TABLE 2.—*Nitrogen distribution in Philippine rice bran.*

Kind of nitrogen.	Rice bran.		Results calculated on basis of total nitrogen. [a]
	Air dried.	Moisture free.	
	Per cent.	*Per cent.*	*Per cent.*
Nonprotein	0.229	0.259	11.439
Protein	1.771	2.005	88.561
Total	2.000	2.264	100.00
Nonprotein:			
Acid amide	0.034	0.038	1.678
Humin	0.019	0.021	0.927
Basic	0.027	0.031	1.359
Nonbasic	0.149	0.169	7.465
Total	0.229	0.259	11.439
Protein:			
Acid amide [b]	0.154	0.174	7.685
Humin [b]	0.049	0.055	2.429
Basic [b]	0.300	0.340	15.018
Nonbasic [b]	1.268	1.436	63.429
Total	1.771	2.005	88.561
Water soluble	0.391	0.442	19.523
Nonprotein	0.229	0.259	11.439
Free amino-acid	0.163	0.173	7.641

[a] Calculated on the moisture-free sample containing 2.264 per cent nitrogen.
[b] Calculated.

TABLE 3.—*The distribution of nitrogen in Philippine rice bran.*

[After acid hydrolysis of the bran.]

Kind of nitrogen.	Rice bran.		Results calculated on basis of total nitrogen. [a]
	Air dried.	Moisture free.	
	Per cent.	*Per cent.*	*Per cent.*
Acid amide	0.188	0.212	9.364
Humin	0.068	0.076	3.357
Basic	0.327	0.371	16.397
Nonbasic	1.417	1.605	70.892
Total	2.000	2.264	100.000

[a] Calculated on the moisture-free sample containing 2.264 per cent nitrogen.

As shown by the data (Table 2) the protein content of the bran is about eight times the nonprotein. Both the protein and the nonprotein nitrogen are largely nonbasic, though they also contain noteworthy amounts of basic and acid-amide nitrogen.

The results we have obtained with rice bran, which contains the rice embryo, agree in general with those of Hamada(12) and Jodidi.(13) Hamada found in the protein of the rice embryo more mono-amino (nonbasic) nitrogen than diamino (basic) nitrogen. According to the investigations of Jodidi the protein of the rice kernel has more nonbasic than basic nitrogen.

A large proportion of the water-soluble nitrogen is nonprotein, which consists principally of free amino-acid nitrogen.

CARBOHYDRATE PARTITION

Experimental procedure.—The different kinds of carbohydrates were determined in accordance with the following methods.

Sugars.—In preparing the solution for sugar analysis, we used the directions given by the Official Agricultural Chemists for grains and stock feeds.(7) The reducing and nonreducing sugars were analyzed by means of Fehling's solution. Munson and Walker's directions(7) were used for the precipitation of the cuprous oxide, which was estimated by the volumetric thiosulphate method.(7)

Starch.—The starch was determined by the diastase method with subsequent acid hydrolysis.(7)

Pentosans.—For this analysis the official method for grains and stock feeds was used.(7)

Dextrins and hemicellulose.—The methods described by Gerhardt for the determination of these two complex carbohydrates in the Grimes apple(14) were followed.

Gums.—A sample (25 grams) was extracted repeatedly with 20 per cent alcohol. The extract was concentrated to a syrupy consistency by distillation under reduced pressure. To the residue a sufficient quantity of 95 per cent alcohol was added to precipitate the gums. The gummy substances were allowed to settle overnight and the supernatant liquid decanted. The gums were then washed several times with a small quantity of 80 per cent alcohol, dried, and weighed.

TABLE 4.—*The partition of carbohydrates in Philippine rice bran.*

Kind of carbohydrate.	Rice bran.		Results calculated on basis of total carbohydrates.[a]
	Air dried.	Moisture free.	
	Per cent.	*Per cent.*	*Per cent.*
Reducing sugars	0.40	0.45	0.87
Nonreducing sugars	5.32	6.02	11.66
Starch	21.34	24.16	46.76
Dextrins	0.46	0.52	1.01
Hemicellulose	0.73	0.83	1.61
Pentosans	8.03	9.09	17.58
Crude fiber	6.32	7.15	13.85
Gums	2.57	2.91	5.64
Undetermined	0.46	0.52	1.02
Total	45.63	51.65	100.00

[a] Calculated on the moisture-free sample containing 51.65 per cent total carbohydrates (including crude fiber).

Results.—Table 4 gives data on the partition of carbohydrates in Philippine rice bran. As shown by these results the starch content is rather high and amounts to 24.16 per cent calculated on the moisture-free sample. This represents 46.76 per cent, computed on the basis of the total carbohydrates of the oven-dried bran. Other carbohydrates, which were present in amounts ranging from above 5 to 17 per cent, were pentosans, crude fiber, nonreducing sugars, and gums.

SUMMARY

High-grade Philippine rice bran that contained no hulls was analyzed and the composition ascertained. The bran contained a considerable amount of carbohydrates (44.50 per cent). The nitrogen in the bran (2.264 per cent) corresponds to 14.15 per cent protein by calculation (Table 1).

Investigation of the nitrogen distribution showed that the major portion of the nitrogenous substances in rice bran consisted mostly of protein, which is composed largely of nonbasic nitrogen.

The partition of carbohydrates in rice bran was also determined. The bran had a rather high starch content (24.16 per cent) and, in addition, contained small amounts of other carbohydrates, such as pentosans, nonreducing sugars, gums, and also crude fiber.

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The results obtained in this investigation are useful in that the experimental data give in detail the characteristics of both the nitrogenous and carbohydrate constituents of Philippine rice bran.

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